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CURSUS MEDICINÆ;  
OR A  
*Complete* THEORY  
OF  
PHYSIC:

IN FIVE PARTS.

- I. The whole doctrine of the ANIMAL OECONOMY.
- II. The nature, difference, causes and symptoms of DISEASES.
- III. The diagnostics and prognostics of DISTEMPERS.
- IV. The method of PREVENTING DISEASES.
- V. The ART of HEALING; or the manner of applying REMEDIES to particular cases.

WITH A

PRELIMINARY DISCOURSE of the rise, progress, success, nature and principles of medicine.

The WHOLE containing all the discoveries and improvements, whether ancient or modern, relating to this subject.

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Done, principally, from those admirable institutions of the learned H. BOERHAAVE, professor of physic in the university of LEYDEN; and improved from others of the most eminent authors.

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By JOHN CRAWFORD, M. D.

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L O N D O N:

Printed for W. TAYLOR, at the Ship and Black-Swan, in Pater-noster-row; and J. OSBORN, at the Oxford-Arms, in Lombard-Street,  
M DCC XXIV.

2205







T H E

# PREFACE.



*HOUGH the superior dignity, and great importance of medicine require proportionable skill in its professors; yet, perhaps, no art is usually practised with less. 'Tis true, both health and diseases are things, in themselves, of a very abstruse and hidden nature; their causes lie deep, and remedies, at the best, are but imperfectly known: however, were there not some considerable fault in the common method of forming physicians, they might, doubtless, be better qualified, than we generally find them, upon leaving the university, and coming into practice.*

## iv *The* P R E F A C E.

Now the grand defect herein, is, by the proper judges, esteem'd the want of a right initiation into the art. And that our own academies labor under this difficulty, is the frequent complaint of those who have had their education there. But when unexperienced youths are, in any profession, left to form their own method of studying, they must be very fortunate indeed, to jump at once into the best; and if a just procedure be necessary in learning the inferior arts, much more is the same required to gain a tolerable knowledge in a subject so exceeding nice and intricate as physic: yet, less care seems now where taken, to direct the wandering steps of the younger students, than in this rugged path, clogged with difficulties, and beset with dangers. And hence it happens, that so excellent an art is often, by physicians themselves, thought to be built on a tottering foundation, and the practice thereof consider'd merely as a trade; hence perfect quackery, with a thousand destructive effects of ignorance.



# *The PREFACE.* V

*To remedy so great an evil among us, the author of the ensuing treatise presents the candidate for physic with the rational elements, or rather a complete theory of the art; for he delivers not only the solid principles and ground-work thereof, but all the discoveries hitherto made, that relate to the subject; and this too, in a method and language the most easy, familiar and intelligible.*

*The institutions, or domestic course of lectures, of the very learned Boerhaave were made choice of for this purpose; as being a most judicious collection of whatever is valuable, both in the ancient physicians and the modern, digested into the clearest method, and deliver'd in the most concise and suitable style. Such a work might, therefore, have answered the end proposed, had it been only faithfully made English; but our author, not content with this, has improv'd upon his model, wherever that seem'd either possible or necessary: whence the work, as it now stands, is the best introduction*



## vi *The* P R E F A C E.

*duction to physic hitherto extant in any language, improv'd and fitted for an English reader.*

*So numerous are the discoveries and improvements, made by the moderns in the theory of physic, that, were Hippocrates and Galen to appear again, they would be surprized to find all their medicinal knowledge fall infinitely short of what this small volume contains ; yet, the whole hereof is so absolutely necessary, that if any one now attempts to practice without it, he thereby demonstrates himself unqualified.*

*This we may safely say, whoever will be at the pains to peruse the following treatise, with that degree of attention the subject requires, cannot fail to receive greater benefit therefrom, than by dipping, after the usual manner, into all the authors that ever appear'd in physic. The true philosophy is happily applied through the whole, the mechanical structure of every part deliver'd, the nature and properties of every animal fluid,*

fluid, with the alterations whereto 'tis subject, fully explain'd, a clear and satisfactory account of diseases given, and the proper remedies for each assign'd; in a word, this work will thoroughly qualify a physician, to practise with equal advantage and satisfaction to himself and patients.

If the reader should enquire, why a book of this character appears in the English language, we answer, 'twas a shame the excellent doctrine it contains should any longer remain unknown to English physicians. For that some of them are so unhappy, as to be ignorant of the Latin original, from whence this was principally taken, may, if other arguments were wanting, be fairly concluded from the ill success of a famous one, in attempting a translation thereof. This gentleman, who out of meer good will, design'd to present the learned Boerhaave to his brethren, in their mother-tongue, has unluckily shewn himself an utter stranger to the manner, sense and language of that great author. We should willingly, however,



# viii *The* P R E F A C E.

ver, draw a veil over so wretched a performance, were it not the utmost injustice, to suppose one of the most careful writers in Europe to be the original author of those institutions, which Dr. Browne has given us. The Dr. indeed, with some justice pleads, in his excuse, the difficulty of the task he undertook; for 'tis no easy matter to translate the thoughts of a Boerhaave, and preserve his peculiar grace and accuracy. To give translations equally perfect with his originals, requires no ordinary degree of skill, of pains and application.



I N T R O



INTRODUCTION;

OR A

PRELIMINARY ACCOUNT

OF THE

*Rise, Progress and Success*

OF

PHYSIC:

WITH THE

*Principles, Nature and Division of the Art.*



HOWEVER has a power to perform human actions, with ease, pleasure and perseverance, is said to be well; and this state of a man is usually called health: but if a person be unable to perform these actions; if he feel uneasiness, pain, or soon grow weary in performing them, we say he is sick; and call this his condition a disease. Now the inclemencies and alterations of the air,  
a which



## X INTRODUCTION.

which is ever absolutely necessary to life ; the nature of aliment, whether solid or fluid ; the force of external bodies ; the vital actions themselves ; and, lastly, the very structure of the human machine must have render'd it subject to distempers, ever since mankind have lived as we do.

The species being thus exposed to pain, diseases and death, presently began to enquire after proper means to remove them. Herein they were led either by the experience of others, or their own inbred curiosity, or instinct. And this gave birth to the art of physic ; which was first practised in *Assyria*, amongst the *Babylonians*, *Chaldeans*, and the *Magi* ; from thence it came into *Egypt*, *Lybia Cyreniaca* and *Croto* : being afterwards translated into *Greece*, it flourished in the *Peninsula* of *Cnidos*, and the Islands of *Rhodes*, *Co* and *Epidaurus*. Accident, therefore, instinct, and unforeseen events laid the first foundation of physic.

The art, thus begun, was soon improved by registering the success of the experiments which were made in it ; the description of the distempers, as well as of the remedies, being graved upon pillars and tables, and upon the walls of the temples. The sick were brought into the public places, and the high ways, that those who passed by might compare their distempers with what they had observed, and apply or advise the use of such medicines as had been found effectual in like cases.



# INTRODUCTION. XI

Medicine was further improved, by constituting proper persons, as physicians, who took an exact account of diseases, and described both them and their remedies. This, in a short time, gained whole families great honour and profit, but especially the priests; tho' the art was cramp'd hereby. The daily sacrifices, the custom of embalming, and opening the dead, gave a competent knowledge of the fabric and structure of sound bodies; as also of the immediate and abstruse causes of health, sickness and death. This knowledge was further advanced by the dissection of living creatures, with a philosophical view; and, by taking a more exact account of the causes of distempers, their beginning, increase, height and decrease; their periods, changes, and different effects in respect of future consequences and accidents: and what greatly contributed to complete this work, was, the knowledge of medicines and their virtues, manifested by experience, with the method of chusing, preparing, and applying them.

*Hippocrates*, well skill'd in these several particulars, and provided with numerous observations of his own, composed, out of the whole, a system of physic, and was the first that truly deserved the title of physician; for, having, with great accuracy, weighed and compared things together, he laid a just foundation of physic for future ages.

This work of *Hippocrates* continued improving amongst the *Asclepiads*, and was



## xii INTRODUCTION.

afterwards digested into a more regular method by *Aretæus*; and, being still further improved, at various times, by several artists, in different countries, it was brought into the school of *Alexandria*, and at last came into the hands of *Galen*.

*Galen* made a collection of their respective writings, digested what was confused, and took a great deal of pains to explain every thing, according to the peripatetic doctrine; this he did with some advantage to physic 'tis true, yet not without many inconveniencies; for, by enlarging the art with tedious explications, and accounting for all things by the four elements, the cardinal qualities, their several degrees, and the four humors, he has shewn much more address than truth in his writings.

Learning, after the sixth century, being neglected in *Europe*; from the ninth to the thirteenth, physic went on improving among the *Arabians*, in *Africa*, and in *Spain*; whereby the *Materia Medica*, and its preparations, as well as what belonged to the art of chirurgery, grew more complete and correct; yet still they persisted in their tedious *Galenical* explications, till those were also confuted and exploded by the *Hippocratic* doctrine, in *France*, on the one hand, and by chymical and anatomical experiments on the other.

At length the immortal *Harvey*, by his discoveries, overturned all the theory of the antients, and placed the art of physic upon a more certain basis. Since his time, it hath  
been

## INTRODUCTION. XIII

been variously improved, without adhering to any particular sect, not only by new discoveries in anatomy, botany and chymistry, but also by physical and mechanical experiments; with the assistance of other arts, as hydrostatics, pneumatics, &c. which have a manifest tendency thereto.

From hence it appears, that the art of physic was first founded upon experiments and observations faithfully collected; whose effects were afterwards explained, and their causes assigned by the assistance of reason. The first part carries conviction along with it, and is indisputable; nothing being more certain than demonstration from experience. The latter is more dubious and uncertain; every sect explaining the causes of particular effects, upon different, hypothetical principles. Some endeavour to account for the phenomena of the fluids in a human body, and the power of medicines in altering them, by a general notion of acids and alkali's; as if the qualities of all material substances were to be reduced to those two general heads: but they might as well reduce all colors to black and white, according as they have a near, or more distant relation thereto; for material substances have as great a variety of forms and qualities, which produce different effects, as there are different materials in which those qualities reside.

Some again would account for the different operations of medicines from the three chymical principles; as if all remedies were



## XIV INTRODUCTION.

produced from, and owed their effects to, salt, sulphur and mercury.

Others take in more, and ascribe all the virtues of medicines, as well as of the natural humors, to spirit, salt, oil, earth and water; but such principles are of themselves too narrow and precarious to be trusted. 'Tis best to have recourse to mechanical philosophy, in accounting for the actions of natural substances; for this comprehends all the other principles, as several branches thereof; some forms of substances producing acids, others alkalies; some bitter, sweet, sour, acid, astringent, &c. others salts, sulphur, or mercury; and others again, spirits of several kinds, and a variety of terrene as well as aqueous parts; all which are endowed with different qualities, and produce as great a variety of effects.

The bodies, which on all sides surround us, are, we see, endowed with different properties; earth differs in appearance and effects from water, wood from stone, and flesh from herbs. This difference philosophy teaches us to attribute only to the different figure, bulk, connection and arrangement of the parts whereof these bodies are composed; for however various the phenomena of them may be, yet, were their component parts reduced to the same figure, bulk, connection and position, they could not but make the like homogeneous masses of extended, solid, divisible, moveable, figurable and passive matter. All bodies, therefore, be they natural or artificial, are mat-



## INTRODUCTION. XV

matter of like kind; or one is as pure and perfect matter as another.

This general matter is separable into similar parts, or such as retain the same nature and properties with the whole; and into dissimilar ones, or such as have some different properties from the whole. The latter separation cannot be performed by triture or comminution, which only resolves a body into its integral parts; 'tis not the mortar, the file, or the mill, but a more powerful agent that must resolve a body into its essential parcels.

Include any vegetable, or animal substance, in a proper apparatus, and commit it to the heat of a gentle fire; first a fine vapor rises, condenses, and turns into a limpid, tasteless fluid. Augment the fire, and there comes over, in vapor, a liquor of a sharp taste, and urinous smell. Increase the heat again, and a cloud of particles will ascend, and adhere, like crystals, to the sides of the vessel. These have nearly the taste of common salt, and easily dissolve in water. Make the fire more fierce, a new cloud gathers, condenses and falls, in yellowish drops, into the receiver. These will float on the surface of what came first over, are inflammable, and bear a resemblance to common oil. What now remains in the retort is black and crusty. Dilute this with boiling water, and 'twill give a saline taste thereto. Depurate and evaporate the fluid, and it will leave shining crystals behind it, resembling salt. Af-



## XVI INTRODUCTION.

ter this lixiviation, there is left a light, brittle, porous and insipid matter. Thus all bodies, unless we ought, perhaps, to except some few, yield, by distillation, five different substances. 1. A water or phlegm. 2. A volatlie fluid, or spirit. 3. A saline matter, or salt, both volatile and fixt. 4. A fat substance, or oil, otherwise called sulphur. 5. And, lastly, a friable, porous body, or *Caput mortuum*. But, the spirit being only a mixture of phlegm and salt, these five may be reduced to four.

Phlegm is fluid, pellucid, volatile, or easily evaporated by heat, insipid and scentless; its component parts may be, therefore, small and spherical, with numberless interstices between them; whereby it is excellently fitted to enter the pores of most bodies, and swell, burst and separate their parts. Thus salt is easily dissolved by it. Upon this account, it unites and blends the other principles together, in bodies; for salts, when diluted, prove dissolvents of sulphurs. This is farther evident, from its effects upon vegetables and animals, where 'tis the chief instrument in preparing and distributing the nutritious juices, by diluting, mixing, dissolving, including, and then conveying the more dry, tenacious, and less pliable parts of the nutriment to their destin'd places. But where this principle exceeds in quantity, the salts are too much diluted, and the sulphurs broke too small; from whence happens a relaxation of texture, an evaporation of the  
more



## INTRODUCTION. xvii

more subtile parts, and a destruction of the substance ; as is daily seen in those plants and animals which too much abound in moisture. On the contrary, those bodies wherein it is deficient, as in wood, stone and metals, preserve their state and form for many ages.

Salt, in general, has three essential properties ; 'tis perceptible to the tongue, easily dissolvable in water, and is specifically heavier than any of the other chymical principles. This, therefore, has its parts so figured and disposed, as briskly to strike and enter the *Papille* of the tongue, that is, its parts are solid and pointed ; 'tis, moreover, very porous ; and, because, in an equal bulk, it contains more matter, its interstices are smaller, than in the other principles. It seems designed to render bodies compact and durable ; and, accordingly, we find, when 'tis extracted, or loses its force, the body loses its texture, and easily crumbles or moulders away.

The purest sulphur, or oil, is viscous, tenacious, adhesive, and specifically lighter than water ; when well purged of salt, 'tis insipid and scentless ; it lubricates, and will not mix with water ; 'tis inflammable, and coagulates with acids ; but liquifies alkalies, and dissolves them ; it granulates and congeals with cold ; and, when pure, evaporates by heat. This principle, therefore, may serve, in composition, to entangle, inviscate, connect and bind the others together, and help to consolidate the whole, whilst



## XVIII INTRODUCTION.

whilst it lubricates and preserves the more friable parts.

The *Caput mortuum*, or elementary earth, is what the fire leaves untouched, a fixed, stubborn and intractible remainder. This freely receives into it self any fluid whatever; 'tis, therefore, very porous, or cavernous, and, consequently, of a texture rare and lax; 'tis friable, and easily crumbles to dust, and nearly resembles a heap of sand. However, it greatly differs from common earth; being insipid, scentless, and consisting of languid, exhausted and exiccated particles; whereas common earth is a mixture of all the chymical principles. 'Tis specifically lighter than the other four, though its parts seem vastly more dense than theirs; being only set at a greater distance from each other. This appears from its obstinate remaining behind, and eluding the force of the strongest fire. Its use, therefore, is to afford a proper lodgment and support to the other principles; to confine and restrain the more volatile parts; and to render all compact and uniform. This seems clear, from its retaining the external, pristine form of the matter submitted to distillation, and its exact resemblance to a case with its numerous cells.

Mercury, or spirit, is only the fine and subtile parts of the elementary bodies, raised by natural fermentation, or the artificial assistance of fire, to the highest degree of volatility and efficacy; but this being only obtainable from salt and sulphur, no more



## INTRODUCTION. XIX

more need here be said of mercury as a principle.

These principles are, perhaps, unobtainable in their pure and perfect state; and substances, 'tis true, may receive a vast variety of forms and qualities from fire; yet the doctrine of them, being deduced from matter of fact, has its use and excellence, and well deserves the consideration of a physician.

Medicine, as it is derived *a medendo*, or assisting nature in the removal of pain, weakness and diseases, and preventing death, properly signifies the therapeutic part alone; which, as being most necessary, was first found out and improved; and this sense the word originally bore: but when afterwards that part, which respects the prevention of distempers, and the preservation of present health, was added to the former, they retained only that single name: all a physician hath to do, being but to preserve the present, and to restore absent, health.

Thus the subject of physic is, a human body consider'd in a natural or disorder'd state, and the end or intention thereof, to preserve health, or restore it; which two parts of the art are sufficient to shew the necessity and usefulness, as well as the nobleness of it; the human body, where-with it is principally concern'd, being, of all others, the most noble.

But, besides those parts of physic, called *ὑγιεινὴ* and *θεραπευτικὴ*, which respect prevention and the cure; there are others, more sublime and requisite, to be known, in order



## XX INTRODUCTION.

der to the better understanding of these ; for, as a physician cannot well tell how to prevent or remove diseases, unless he first understand the substance he is to work upon, as well as the qualities of the medicines he uses ; so it is necessary he should make strict and accurate observations on all the phenomena, or accidents, discoverable, either in a sound or a distemper'd body, in one that is dying or already dead ; whether they proceed from internal or external causes, or are produced by accident or art. A physician is likewise to consider, what latent causes, in human bodies, may concur to produce such phenomena ; and what may be necessary to prevent future ill accidents, or secure a good event.

And, in this case, he is to make use of his reason, and always to weigh and compare his experience therewith, as strictly as possible ; considering the properties of bodies, and of the natural humors and medicines ; and at the same time observing what is either agreeable, or disagreeable to nature : and these things are to be weigh'd with prudence and exactness, that he may be the better enabled thence to deduce just consequences, and judge of future events.

In order to this end, it is requisite we should fix upon some principles, which may serve as marks, and assist us in explaining the phenomena of natural bodies, and accounting for the accidents that may arise therein ; the effects produced in natural humors, or those of medicines made use of.



## INTRODUCTION. XXI

of. And, in this case, the *Boylean* philosophy may be most assisting; being purely mechanical, and grounded upon physical experiments. We are likewise to consider, the natural strength and dispositions of bodies, and to compare the works of nature together, which may direct and assist us in forming the rules of art.

And, that we may the better understand the operations of human bodies, whereto a physician should be assisting, and know how to help her where she is deficient; we are to consider, that man is composed of a soul and body, united together, which are of different natures, who, therefore, manifests actions and passions of different kinds; yet - is there such a reciprocal connection and consent betwixt these two parts, that the operations of the mind are affected and variously determined by the state and condition of the body; and on the contrary.

But tho' the thoughts may, in some measure, be differently disposed by the influence of the humors of the body; yet the soul hath some particular thoughts, which the body has no effect upon: and so the body performs some particular operations, which are involuntary; though, in some measure, alterable by the concurrence of the voluntary actions, and influence of the spirits, variously distributed, according to the different passions of the mind. But how far the soul is influenced and disordered by the distemperatures of the body, and the fluids contained therein; or, on the contrary,

## XXII I N T R O D U C T I O N.

trary, how far the body is disorder'd by passions of the mind, must be judged of by observation.

The operations of the mind, and those of the body, are not confusedly to be consider'd together ; since what disturbs the mind, is principally owing to the distractions and disorders of the soul ; whereas the diseases of the body, almost always depend upon the figure and motion of the solid parts, and the various dispositions of the fluids contained in the vessels ; and are explicable by their particular properties, and peculiar qualities, resulting from the different forms of the parts, whereof those fluids are composed.

And, that a physician may be qualified for this consideration, he ought not only to be well skill'd in the anatomical, chymical, mechanical and physical experiments, and those which come under natural philosophy ; but, in his enquiry into, and reasoning about them, he must begin with such as are most simple, easy and certain ; and thence proceed to those of the first degree in composition, which will lead him to the more compound, difficult and obscure.

And, as he that would learn ought to proceed from particulars to generals ; the method of instructing proceeds from generals to particulars ; which we shall here observe.

And since a physician ought, in the first place, to understand the nature of a human



# INTRODUCTION. XXIII

man body with all its parts, both solid and fluid, that he may be thoroughly acquainted in what health consists; so, in the next place, he is to consider what alterations nature is subject to, which may produce diseases; and also, what are their differences, causes and effects, and how they are to be distinguished and known. To this end physic is divided into five parts; *viz.* Φυσιολογική, παθολογική, σημειοτική, ὑγιεινὴ, and θεραπευτική.

The first general part, which is called physiological, treats of the parts of a human body, their structure, disposition, uses and actions; together with the faculties of the soul. The objects of this part are called things natural, or things according to nature.

The pathological part treats of diseases, their differences, causes and effects, or symptoms, whereby human bodies recede from their natural state. This is called παθολογική, as it describes the diseases of the body; *αιτιολογία παθολογική*, when it treats of causes; παθολογία, or νοσολογία, when it treats of their differences; and συμπτωματολογία, when it explains the effects, or symptoms, of diseases. The objects of this part are those things which are called preternatural, or things contrary to nature.

The semiotic part shews the signs, which distinguish between sickness and health, diseases and their causes, which lie concealed in human bodies; and also the signs of the event of distempers, or their prognostics.

## XXIV INTRODUCTION.

nostics. The objects of this part are things natural, non-natural and preternatural.

The fourth part, called ὑγιεινὴ, shews what Remedies are proper, and how they are to be used to preserve health, as much as possible, and to prevent distempers. The objects of this part are things non-natural.

The therapeutic part instructs us in the *Materia medica*, or proper medicines, their preparations and use, in order to restore health, and remove distempers. This fifth part, called θεραπευτικὴ, employs the διατητικὴ, which respects diet; φαρμακευτικὴ, the preparation of medicines; χειρουργικὴ, which teaches manual operations; and μέθοδον ἰατρικὴν, which is the method of healing.

Having thus briefly premised the rise and progress of physic, and the principles we shall make use of, with the general nature and division of the whole art, we shall next proceed to consider those divisions distinctly.







A

Complete THEORY

OF

PHYSIC.

PART I.

CHAP. I.

*Concerning* PHYSIOLOGY, *or the Animal*  
*Oeconomy in General.*



THE design of physiology is to instruct us in the nature of human bodies; the temper and constitution of the whole, and of every part; together with their uses and actions, in order to qualify us to pursue, with advantage, the end of physic, which is, as was said, to preserve and restore health. And since

B

since



since we cannot know the nature of human bodies, their temper, constitutions, actions and uses, without understanding the frame and structure of the whole, and the several parts; what vessels they are supplied with; what parts they are composed of; what fluids circulate thro' them; and what alteration they undergo; and are subject to from the vessels they pass through; the use of the non-naturals, or errors in nature: I say, since the knowledge of such things is necessary to obtain the art of preserving or recovering lost health, whoever designs to improve himself in that art, ought to be well skill'd in anatomy; the structure of the whole body, and all the parts that go to compose it.

As a human body, therefore, consists of solids and fluids, the structure of the vessels containing the fluids, is not only to be understood, but also the nature, disposition, and qualities of those fluids themselves, before we can well apprehend the use or actions of the parts. So that a young physician ought to improve himself in both, not only by reading proper books of anatomy, and of the nature of the animal juices, but also by applying himself to such methods as may demonstrate those things more exactly; as anatomical dissections, both of dead and living bodies, with actual experiments and observations made upon the animal fluids; being all along careful to compare art with nature. The evidence of our senses, either by taste or smell, or both, will in a great measure satisfy us of the manifest qualities of such fluids as are naturally contained in the several vessels of human bodies; and when once we are well acquainted herewith, this may lead us to a knowledge of the use of the parts, and of what alterations they receive therefrom.

And



And the body, as we said, being composed of firm vessels and fluid liquors; when we know what vessels compose any part, and what communication they have with each other, as also what fluids are brought or secreted by those vessels; this will inform us of the use and action of the parts, as well as the manner of the action. For when we know the qualities of the fluids brought to any part, and the nature of the liquid there separated from it, we are certain that the use and action of that part was to make such an alteration in the original fluid, as should suffice to prepare it to separate, and afford the other; and that the part was properly contrived and disposed in its formation to answer such an end.

Since, then, the parts of a human body are very different from one another, not only the temper and disposition thereof must vary, but likewise their structure and conformation. Some parts are called similar, others dissimilar. Those are term'd similar, whose peculiar component fibres appear all of a like nature and substance, as a bone, a cartilage, flesh, a fibre, fat, and others; which tho' they appear, at first sight, similar, if more nearly examin'd, have other parts interwoven in their composition, as veins, arteries, and nerves: however, they are esteem'd similar, from their appearing homogeneous, or of the same nature. Those parts are called dissimilar, which are composed of several similar parts: They are also called organical; though, properly speaking, the word similar is not used in opposition to organical, only as the parts it denotes differ in being less compounded; for a similar part also may be said to be organical; as the bones, which have an organical use; yet since these parts, usually called similar, do not perform a perfect and entire action

of themselves, they are therefore called similar in contradistinction to those which are more properly organical.

From hence it appears, that similar parts and such as compose or concur to compose organical ones, differ from one another in qualities according to their different formation, and various modes, and manner of action: And tho' a Part be termed organical from its apt composition and conformation, which renders it fit, of it self, to perform animal functions, yet there is a strict and entire union betwixt both similar and organical parts; for the whole body is not only perfectly united together; but all the parts thereof, whether similar or dissimilar, are mutually interwoven with each other.

As the body is composed of distinct parts, closely united, the solid parts themselves are compounded of several fibres, conveniently and aptly connected together, so as to render the whole machine vascular; whilst the several vessels have so regular a communication one with another, that the liquids contained in each may be continued in a constant motion and circulation, according as they are protruded forwards by the force of pulsation.

In the construction or formation of the solid parts we find, that though they are all vascular, for the conveniency of circulation and nutrition, yet, according to their different offices and uses, some, for the firmness and stability of the body, are formed like pillars, supports, or buttresses; some like arches to cover and defend others; some like props, wedges, levers and pulleys; others like cords, presses or bellows; and others again like sieves and strainers, pipes, conduits and reservatories: And the service they  
all



all perform, which is done mechanically, is called their office or use.

As to the fluid parts, these being contained, according to their respective natures, in different vessels, are kept in a constant and determinate motion, according to the laws of circulation, and are often mixed together, separated again, and altered in different parts of the body, according to the different offices and use of the vessels they pass, or are strained through, and the different degrees and manner of fermentation they undergo, to fit and dispose them to their several separations or filtrations.

The food which is taken in at the mouth, after mastication or chewing, if necessary, is conveyed through the œsophagus, along with liquids, into the stomach, and is there digested into a kind of pulp, wherein the solids are dissolved and blended with the fluids; and thence, being conveyed into the duodenum, by the mixture of the pancreatic juice and bile from the *Ductus Choledochus*, it is alter'd and reduced into perfect chyle, the feces being separated from the purer liquid.

The chyle thus prepared is received and pressed into the lacteal vessels, which convey it to the mesenteric glands of the first order, where lymphatics from several parts, as well as in the glands of the second and third order, accelerate its motion towards the *Receptaculum Chyli*, or the mesenteric gland, where, as well as in the *Thorax*, it hath a fresh supply of lymph, impelled by the force of circulation, to quicken its motion through the *Ductus Pecquetianus* into the left subclavian vein.

When the new chyle is thus mixed with the blood, it circulates along with it, and is first conveyed to the right auricle of the heart, and

thence through the right ventricle thereof, into the *Vena arteriosa*; and thus, passing through the lungs, 'tis carried to the left auricle of the heart, by the *Arteria venosa*; and, being thence received into the left ventricle, is dispersed thro' the whole body, by the ramifications of the aorta, where it receives its proper alterations in the several parts, according to their respective uses and functions, and returns again to the heart by the veins.

And as the blood and chyle thus circulate through the veins and arteries, so all the rest of the fluids in man's body are in a constant circulation.

The lymph, which by diluting accelerates the motion of the chyle through the lacteals, also thins the blood and serum, and is again separated in the lymphatics, and often repeats its course: the bile, which is separated in the liver, and digests the chyle, is again separated in the liver, and mixes with new chyle; or, as part of it is expended, a fresh supply is made; and thus the spirits, which secreted in the cortical part of the brain, pass through the nerves, digest the blood, and promote the proper ferment and function of every part, are again supplied by the brain, and conveyed to the nerves.

Thus all the fluids are in a constant motion through the vessels, whose sides are thereby rubbed, moved, distended and restored to their places again. The Fluids, thus move according to mechanic and hydrostatic rules, as water runs through pipes in an hydraulic or water-engin; but to determine their actions one upon another, the nature of each is to be well considered, examined and scrutiniz'd by frequent experiments of various kinds, and their evident qualities



lities discovered and confirmed by the testimony of our senses.

From hence it may in some measure appear, what is the state of the human body in health ; for since men, as we said, are well, when they can rightly perform the natural actions of life, so he is to be called healthy, whose body is in a fit condition for performing such actions, as depend upon, and flow from the due temper and constitution of all its parts. *Galen* says, *ἡ τὸ ἐνεργεῖν ἐστὶ τὸ ὑγιαίνειν ἀλλὰ τὸ δύννασθαι*, i. e. 'tis not action, but the power to perform it, that proves a man in health : And he elsewhere calls health, *διὰθεσιν κατὰ φύσιν ἐνεργείας ποιητικὴν*, a natural disposition of all the parts of the body, enabling it to perform the actions of life.

Yet there is a certain degree of latitude in respect of a heathful disposition of body ; for all men shew not the same degree of perfection in their actions ; but in respect of their age, sex, and other circumstances, one will perform either all sorts, or some particular actions, more perfectly than another, yet they are both said and esteemed to be in health.

Another thing, which makes a great difference in the degrees of health, is the difference of constitution, that is, of the different qualities of the several humors and disposition of the parts of the body. The similar, as well as the organical, differ in temper according to the different qualities of the fluids, wherewith they are nourished ; and the original impressions made by the primary nourishment they received in the womb, which lays the first foundation of a future constitution : or again, the parts of the body, as well solid as fluid, may be impregnated with foreign qualities, as the *Semen virile* happens to be disposed ; the first rudiments of the body, as

well as the primary humors, being apt to change into different tempers, with the first ferment they happen to acquire.

The temper of a man's body, when in health, may be said to be good in a twofold sense, that is, either simply and absolutely, or with relation to something else of the kind; for if there be such a just proportion of all the qualities which appear in different constitutions, so that none of them exceeds the others in quantity, such a constitution simply and absolutely may be said to be good and temperate; and this disposition of body is called *Temperamentum ad Pondus*, or a temper according to exact weight or due calculation: but if there be a disproportion in the humors, as to one or more qualities, which yet are agreeable to, and hinder not the peculiar actions of that body, this temper is called *Temperamentum ad justitiam*, or a disposition of body suitable to such a constitution; though this, in respect of the former, may be called *Intemperies*, or an indisposition of the humors.

But, to proceed, this temperature, in which there is not an exact proportion of different qualities, assumes a different denomination from that quality which is prevalent and exceeds the rest, whether it be one alone, or two joined together; and the accident or action, produced by that peculiar temper, is ascribed to the most prevalent quality, though they are all in some measure concerned therein.

Some of these constitutions are called simple; others compound: that is called simple, when one particular quality exceeds its opposite, and the rest are equal or undistinguishable. The simple constitutions are four: that is said to be hot, when heat is prevalent, and other qualities are justly proportioned; cold, when that is easily



sily distinguished ; moist, when superfluous ferocities make themselves evident ; dry, when the body is otherwise temperate, but wants sufficient nourishment, and a just proportion of juices.

But when two qualities exceed the others, a constitution is called compound ; of which there may be four kinds : thus, a constitution may be hot and moist, as in scorbutic defluxions, when too much hot serum is discharged upon the parts ; hot and dry, as in a fever ; cold and moist, as in hydropical distempers ; and cold and dry, as in a marasmus : yet in all these cases there is a wide difference, in regard to the several degrees wherein they fall short or exceed.

The constitution most proper and agreeable is hot and moist ; which is twofold, *viz.* either properly belonging to the primary and natural temper of the body ; or, acquir'd by the use of the non-naturals, or the assistance of art : and this constitution, or temper of the humors, is most commodious to mankind, and qualifies them best for action, and is most consistent with health and longevity : whereas, the contrary temper, cold and dry, tends to decay and death : for the sooner a body withers and dries away, the sooner it grows old and draws near its period of life. This heat and moisture hath also its several degrees ; for these qualities are best when moderate : those which differ and recede from that mediocrity, are called hot and moist, hot and dry ; or cold and moist, and cold and dry ; though all in general are hot and moist in some degree.

These differences of tempers are commonly distinguished by the denominations of sanguin, choleric, phlegmatic and melancholic constitutions, according to the nature and disposition of the juices in the several bodies, where the excrementious

tious discharges answer thereto. They whose blood is of a moderate temper, between hot and moist, are called sanguin; those who exceed in heat, and whose blood is dryer, are called choleric; those who are cold and moist, phlegmatic; and lastly, those who are cold and dry, melancholic.

As to the different tempers and constitutions of men, they, in great measure, depend, not only upon the various dispositions of the humors contained in the body, but also on the peculiar conformation and structure of the noble parts, and their various proportions in respect to each other, which disposes them to breed humors of different kinds and dispositions; and endows them with various qualities, according to the several alterations they undergo in different bodies, and the various proportions of such differently fermented animal fluids, exceeding or falling short in degrees of digestion; or being variously depraved or vitiated by the assimilating qualities of humors already contained, or of fresh food taken into the body, which may pervert the crasis or disposition of the fluids already contained in the sanguiferous vessels.

The proportion of the parts and their conformation may contribute to the difference of constitutions, as they separate and discharge humors, not only differently prepared, but in greater quantities: thus, if the heart be larger in proportion to the body, than the rest of the parts, the blood must circulate more briskly and with greater force; if the liver be large, and separate a great quantity of bile, the chyle and blood must be more bilious; and as the stomach differently digests, the blood must be supplied with nourishment in greater or less quantities, more or less digested; and so occasion either cho-  
leric



leric or phlegmatic constitutions. Thus the noble parts contribute to the different temper of the whole, as well as of themselves other particular parts.

For this reason it is that different parts of the body are, in respect of one another, esteemed of different tempers; as the heart, upon account of its situation and constant motion, may be reckon'd one of the hottest parts of the body. The others reckoned of a hot temper, are the liver, the musculous flesh, the spleen, the kidneys, the lungs, the veins, arteries and fat. The cold parts are the bones, cartilages, ligaments, tendons, nerves, membranes, spinal marrow, and the brain. Those which are accounted moist, are the suet, the marrow, the brain, the breasts, the testicles, the lungs, the spleen and kidneys, the musculous flesh, the tongue, the heart, and the softer nerves. The dry parts are bones, cartilages, ligaments, tendons, membranes, arteries, veins, and hard nerves.

There is yet another difference in the temper and constitutions of human bodies, in respect of sexes and age; thus women are naturally colder than men, too much heat being supposed apt to consume and vitiate the tender nourishment of infants, which is to be prepared in the mother. Age alters constitutions, according to the several stages and periods thereof; thus infants and children are hot and moist, youth more temperate, men and full-grown persons hot and dry, whereas in old age the heart decreases, and their nourishment is dried up for want of its usual supplies.

Another thing that makes constitutions differ, is the difference of climates, manner of living, the nature of the food they use, and the liquors, wherewith the more solid parts of it are diluted.

In

In former ages, water, and the products of the earth, were the only aliment, as appears both from sacred and profane history, and from nature it self. Mankind, after the deluge, began to feed upon the parts of animals, their juices, and the fruits of the earth artificially prepared; though many, even to this day, feed upon nothing but vegetables, and use only water for drink. Some live almost wholly upon fish; others upon flesh and milk; whilst others again make use both of vegetables, fish, fowl, and other animals.

Thus mankind, after different manners, are nourished, and support their strength. Nor does the variety of food much alter the substance or actions of their bodies, the parts thereof having the power of altering and assimilating any thing into a like substance with themselves; yet it is evident by daily observation and experience, that this action of assimilation is more easily performed, according to the difference of the food, and the nature of the liquors taken in; as also according to the different method of preparing or dressing that food; and, further, according to the temper and disposition of the body, and the different degrees and capacity of digestion and sanguification.

The fruits of the earth, when ripe, as corn, and others of the like kind, being dried, cleansed and ground, mixed with water, then fermented and boiled, are very nourishing, easily digested, and serviceable in preserving man's body. But the parts of animals, when boiled, baked, roasted or fried, afford the best nutriment, and are more easily digested, especially when boiled or baked. And sauces, which promote digestion, and excite the appetite, are chiefly made with salt, vinegar, spices, and oil. Fruits, when they are fully ripe, their softness makes them easily dissolve  
and



and digest, so that they want no other preparation to render them fit for use.

As for drink, if water alone be made use of, crude running water is best; but if there be insects, or such like creatures therein, it is fitter for service, after being moderately boiled, and settled, that the slime and extraneous bodies may fall to the bottom. And as to liquors made by decoction of fruits, or any sort of grain, the advantage of them is easily understood; nor is the use of malt liquors less known, or the goodness and wholesomeness of common wines; all which are prepared by attenuation, digestion, dilution, and separating the grosser parts from the more fluid; which are therefore more easily digested, separated and discharged by the natural actions of the parts of human bodies, and the common and natural emunctories.

From what hath been said of physiology in general, the nature of a human body, the object of physic, in some measure appears. We see it not only depends upon a due temper and disposition of the juices, but also on a regular conformation of the parts that prepare them, and perform all the functions necessary to such a creature. To which purpose both the similar and organical parts are to be rightly disposed; and have a natural conformation to render them fit for action; and this in respect as well of the number of the component similar ones, as of their form, magnitude, connection, and situation, with a perfect harmony amongst all that go to make up the fabric.

The differences of the animal functions, and actions in a human body, have generally been divided by physicians into animal, vital, and natural, in respect of the three principal parts of the body, the brain, the heart, and the liver:

But



but since whatever is animal or vital, is also natural, and all these jointly tend to preserve life, and in respect of the end of their actions, have the same intention; and since other parts, as well as they, have their distinct offices, and jointly contribute to complete the animal œconomy, and prepare those juices which are requisite to sustain and preserve life, I shall here lay aside these distinctions, and consider what is the action and fabric of each part. For having said thus much of physiology in general, I shall proceed to take a view of it in particular, and shew not only the natural structure and use of the parts, but how they all contribute to answer the ends of nature; not only as they are subservient to the operations of the body, but likewise to those of the mind, being both to be considered as join'd together, and as they reciprocally affect each other.



## CHAP. II.

*Concerning the Action of Mastication; the Origin of the Saliva; with its Nature and Mixture.*

**I**N treating of physiology; in particular, that we may as well understand the frame and fabric, as readily conceive the action and use of every part, and see what share each hath in forming the whole mass of fluids, I shall distinctly consider each part by it self, and examine how natural bodies are render'd capable to  
 carry



carry on the designs of nature ; wherein I shall trace the footsteps of nature it self.

And since a human body was originally formed in a perfect state of health, and in full proportion, with food ready provided for it, I shall first consider how food is converted into nourishment fit to preserve health, and continue life ; because this being once understood, it will more easily appear how nature may be vitiated, and health impair'd, and how a physician may best preserve, or restore it.

To begin, then, with the first steps that nature takes to preserve health and continue the life of a man, by supplying him with convenient nourishment. When solid food, whether prepared by nature or art, is receiv'd into the mouth, it there undergoes several alterations, by biting and chewing thereof, the mixture of the natural mucus of the part, and the saliva which flows therein, together with the insinuation of the air.

In biting, the lower jaw is drawn down from the upper towards the breast, the *Processus Condyliformis*, being articulated above with the protuberance of the *Os Temporum*, by a ligament encircling the whole articulation ; a moveable cartilaginous plate interposing, which is fixed to neither of the bones ; but the ligament of the articulation, at the verge of its circumference, and hollow on both sides. Another thing required in biting whilst the lower jaw continues thus drawn down, is, that it be again forcibly pressed upwards against the upper jaw, that whatever is interposed betwixt the eight foremost teeth, called *Incisores*, planted opposite to each other in either jaw, may be cut asunder. •

The first action is performed by the muscles, called *Biventre*s ; they rise fleshy out of a small hollow in the basis of the *Processus Mastoideus*, and dege-

degenerating into tendons, pass through the muscle, called *Stylohyoideus*, and the annular ligament fixed to the side of the *Os Hyoides*; when they grow carnosus again, and being furnished with fleshy fibres from the *Os Hyoides*, they ascend to, and are inserted in the middle of the chin, on the lower and innermost side; being thus placed lowest of all, they act by the mechanical direction of the pulley, through which the tendon passes; their power and direction being very artificial and surprizing.

The latter action is performed by the contraction of the temporal muscles, which rise with a large semicircular carnosus origin, from a cavity in the *Os Frontis*, *Sphenoides*, and *Ossa Squamosa*, whose fibres meeting and uniting together under the *Os Jugale*; and being strengthened and directed by other fibres received from thence, they become partly tendinous, and partly carnosus, and are inserted into the *Processus Coronoides*, of the lower jaw, on either side. The masseter muscles are also concerned in this action, which rise thick and fleshy from the first bone of the upper jaw, from the *Os Jugale*, whose fibres intersecting one another, are inserted into the external and lower edge of the lower jaw about four fingers breadth from the middle thereof. The *Pterygoideus externus* springing from the external part of the outward wing of the *Processus Pterygoideus*, in the *Os Sphenoides*, and also from the upper part of the same bone backwards, is inserted, with a strong tendon, in the semilunar cavity, situated in the inside of the lower jaw, betwixt the condyloid and coronoid processes; these muscles move the jaw forwards and upwards when they act both together; and obliquely forwards to one side when only one of them acts. The *Pterygoideus internus* has a fleshy and tendinous beginning from the whole  
internal



internal surface of the external table of the *Processus Pterygoideus*, and descending with a strong and broad tendon in a dent a little above the internal angle of the lower jaw, under the great apophysis; when the two act together, they draw the jaw, along with the masseters, strongly upwards and backwards; and laterally and backwards when only one acts. When these eight muscles act together, they draw the lower jaw against the upper with a vast force, setting the teeth of both firmly one against another; and thus the fore teeth, called *Incisores*, being strongly pressed together, perform the action of biting.

The food being thus divided by biting, is forced in betwixt the unequal broad ends of the teeth, called *Molares*, or grinders, to be further divided. 'Tis thus forced in betwixt the grinders, first by the contraction of the muscle, called *Buccinator*, which rising broad and fleshy from the fore part of the coronoid process of the lower jaw, adheres fast to the gums of both, by direct fibres, which passing along the cheeks, are inserted into the corners of the mouth, and press the cheeks close to the outsides of the grinders. The orbicular muscle of the lips is fastened by membranous ligaments to the gums in the middle of the upper and lower lip. This muscle encompasses the mouth and lips with its carnosus fibres, and is inserted into no bone, but draws together, contracts and shuts the mouth. The zygomatic muscles, rising fleshy from the external part of the *Os Jugale*, and descending obliquely, are inserted about the corner of the lips, and draw them obliquely upwards, and press a portion of the cheek, near the upper part of the *Buccinator*, against the gums of the upper jaw. The next muscle assisting in this action, is the common elevator of the lips, which from the

fourth bone of the upper jaw is inserted into the corner of the lips, under the tendon of the preceding muscle; it lifts the lips more directly upwards, and closes them, as well as that part of the cheeks, to the gums. The proper elevator of the upper lip is double; one part rises from the same fourth bone of the upper jaw, above the other, and descending obliquely, terminates under the skin of the upper lip; the other rising from the fore part of the upper jaw, about the middle of the lower part of the nose, is dispersed in the middle of the upper lip; which muscles acting both together, press the upper lip, contracted by the sphincter muscle, against the uppermost fore teeth and gums. The proper depressor of the lower lip, rises from the lower part of the chin, and is inserted into the lower lip. The proper elevator of the lower lip rises from the fore part of the gums of the lower jaw about the *Incisores*, into the lower skin of the chin. These muscles, by the assistance of the common depressor of the lips, which hath a carnosus origin from the lower verge of the lower jaw, ascending on the side thereof, is inserted in the corner of the lips. The oblique muscles of the lower lip, rising from the middle, lower and fore part of the lower jaw, ascends obliquely into the lower lip. The *Platysma Myoides* lying just under the fat, spreads over all the breast, almost down to the paps, with a broad membranous and tendinous expansion upon that part of the pectoral muscle; and being continued from thence above the clavicles, over the neck, under the chin, and over part of the face above the masseter muscles as high as the basis of the nose, it strictly binds together with its tendinous fibres, all the muscles it passes over, as well as presses the cheeks to the jaw bones and the grinders, and shakes the integuments of the breast,



breast, neck, chin, and lower part of the face: hence if all these act together, both the cheeks and lips are pressed so forcibly against the gums and teeth, that neither meat nor drink can fall betwixt them; but if they act successively, then they are moved and rolled about from one place to another. The same compression is made by the tongue, a muscle the most apt for motion of all the rest, and easily rolled about the whole mouth. First, by the muscles called *Genioglossi*, rising carnosus from the inward part of the chin, and spreading in their course, are inserted into the root of the tongue; these contract and draw the tongue forwards. The *Ceratoglossi*, rise broad and fleshy from the side of the *Os Hyoides*, and thence plentifully disperse their fibres thro' the tongue; they draw it backwards, press it down, and make it broader. The *Styloglossi* rise sharp and fleshy from the external part of the *Processus Styloides* of the *Ossa Temporum*, and descending forwards, insert themselves into the back part of the tongue; this they lift up, draw aside and extend in breadth; fleshy fibres being inserted from thence out of the body of the tongue into the jaws on the lower side. The longitudinal muscles which form the body of the tongue, contract and make it shorter; the transverse make it narrower, and the perpendicular make it thinner; others contracting the back part and sides thereof, draw it sharp and inwards; others, in the same figure, press it downwards; and the strait ones contract the root of it together. All these being conceiv'd to act either separately, or in various combinations together, easily explain the various motion of the aliment among the *Dentes molares*; especially if the joint action of those fibres which pass from the tongue amongst the external muscles be considered.

From whence it appears how, by the different motions of these muscles, the food being successively thrown betwixt the grinders, is broke, and when sufficiently ground, moved away therefrom.

But besides those changes which the food undergoes in chewing, it suffers others by mixing with the saliva, and mucus of the palat and jaws; as also with the air in the mouth.

At the root of the ear, betwixt the mammillary and condyloid processes, and the *Os Jugale*, lyes a conglomerate gland called *Parotis*, containing in its cavity a conglobate gland, largely extended backwards, forwards and downwards. This separates the saliva from the arterial blood, into a common duct, which discharges it into the mouth through the buccinator muscle, at about the third of the large jaw-teeth.

Within the jaw there is another called *Maxillaris interna*, or the gland of the inward jaw, which is large, and from a broad beginning extended almost the whole length of the jaw, which also separates the saliva from the arterial blood, and discharges it into an excretory duct, rising behind it and proceeding forwards almost as far as the foremost of the *Dentes incisores*, it receives the saliva, as it passes along from the other part of the gland, by lateral branches of that duct, and discharges the same by two ways, near the fore part of the bridle at the root of the tongue.

To these we may add the *Sublinguales* of *Bartholin*, which perhaps owe their original to the former; their mouths, after the same manner, opening under the tongue.

The palat, tongue, gums, and lips, also abound with small ducts, which discharge a similar, but much thinner liquor.

Besides these, the tonsils, which are two glands lying on the sides of the under jaw, disperse from their



their cells, sometimes by one duct, and sometimes by more, a thickish kind of liquor to the parts adjacent. The *Fretum Stenonis* also, which are holes passing along the bones of the upper jaw near the fore-teeth, and meeting together, convey into the mouth the liquid part of the mucus of the nose; as also the tears that run into the nostrils; though both these make but a small quantity.

The glands of the fore part of the palat, but especially of the back part, as also, those of the uvula, separate a mucus, which is mixed with the food in mastication: and these fountains or emissaries are so placed, that they afford the liquors separated by them more plentifully in the action of chewing, or speaking; and perhaps other glands of this kind may not hereafter be discovered. In brutes there are others.

The saliva is a thin transparent humor, almost void of taste and smell, entirely evaporates, but does not curdle by heat; and when shaken, affords a rosy froth: it is separated from the arterial blood by the glands. When a person is hungry, it flows in greater quantities, and is then more fluid and sharp; after long fasting it is very penetrating, detergent, and dissolves more briskly; it ferments with bread, meal, or syrups, and promotes digestion; men, as well as brutes, swallow it in health, and also when asleep: when too much of it is spit out, it occasions loss of appetite, slow digestion, and an atrophy or consumption. It is composed of many aqueous and spirituous parts, with a moderate quantity of oil and salt, which renders it saponaceous.

But farther, we find that the saliva will precipitate a solution of *Saccharum Saturni*, or of corrosive sublimate, in the form of a white powder, which is the property of an alkali; yet it changes not the colour of a tincture of mallow-flowers, nor

ferments with acids. When view'd through a microscope, it appears to be oblong, branching particles swimming in a limpid fluid; like what we observe upon mixing wine with water. Being distill'd either alone, when fresh, after fermentation, or lastly with spirit of wine, it yields, 1. Various liquors of a watery and saline nature, which will turn a tincture of mallow-flowers green, precipitate a solution of sublimate, and ferment with spirit of nitre. 2. Many drops of a thick solid oyl. 3. The remainder, calcined and made into a lixivium, affords a small quantity of fixt salt. 4. Very little *Terra damnata* is left behind. The saliva being thus composed of a large proportion of phlegm, a considerable one of volatile alkalious salt, some sulphur, a little fixt salt, and less earth, is wonderfully fitted for its several uses.

This fluid then being pressed out of the glands, and perfectly mixed with the food, ground small by the action of chewing, lays the first foundation of assimilating the aliment to the body, and like an apt menstruum, or medium, promotes the mixture of oily and aqueous substances, and the solution of saline ones; it also promotes fermentation, excites an intestine motion of the parts of the food, and causes an alteration both in their taste and scent; it likewise affords some small and present refreshment, and being it self insipid, alters not the relish of such things as are sapid.

Since then this fluid is separated with so much art from the purer part of the arterial blood or serum, and is of so great use, when mixed with the food, it ought not to be lavishly spit away; for when it is swallowed, having perform'd its office in the mouth, and being returned into the blood, it is further improved by repeated circulation and digestion; and when separated in the glands again, is highly meliorated; and this seems confirm'd by medicines, diseases, and their crises.



By the same act of chewing, the air, as well as the saliva, the mucus of the tongue and palat, being perfectly mixed with the food, thus reduced to a pulp, by the pressure, fluidity, elasticity and rarefaction of the former, together with the heat of the body, and a continued series of various compressions, the whole mass is attenuated and rendered thinner, and the intestine motion of the parts being once begun, is by this means farther continued.

The food thus ground small, perfectly mixed and diluted, and impregnated with a slimy quality, is at length forced back towards the jaws or hindermost part of the mouth; in which action the teeth are fixed close together, and the muscles of the cheeks and lips contracted; which assisted by the motion of the tongue, the back part whereof is at the same time dilated and expanded, so as to possess the space on both sides betwixt the upper jaw and the palat; the food contained betwixt the tongue and the palat, which is conveniently formed to determine the motion of any thing forced against the jaws, is closely compressed, whilst the muscles called *Genioglossi*, the longitudinal muscles of the tongue, the *Styloglossi* and *Ceratoglossi*, act with a successive motion, and form a cavity at the root of the tongue, under the cover of the palat, uvula, and tonsils, but above the larynx and pharynx, and before the membranes which bind the *vertebræ* of the neck, and the posterior muscles of the pharynx together, by which means whatever is there contain'd, is kept so close, in order to be swallowed, that not one drop can escape or slip away.

Then by the action of the *Genioglossi*, and sometimes of the *Myloglossi*, or the lateral fibres of the *Geniohyoidei*, which rising from the inside of the chin, under the *Genioglossi*, are fixed about the articulation

articulation of the small cartilaginous horns, to the *Os Hyoides*; the *Os Hyoides* and whatever is fixed to it, being forcibly brought forwards and upwards: and also, by the action of the *Mylohyoidei*, which rising with a large tendon, from the middle part of the basis, of the *Os Hyoides*, is fixed by a large aponeurosis to the lower jaw, near the grinders, even to the fore part thereof, possessing all the space betwixt the *Os Hyoides* and the inside of the lower jaw, the *Os Hyoides* being almost close on every side to the jaw, drawing upwards and forwards, and lifting up the tongue, and all that lies upon it; the *Styloceratohyoidei*, also rising acute and fleshy from the styloform process of the *Ossa Temporum*, and descending obliquely forwards, are penetrated by the digastrics, and inserted into the articulation of the greater horn with the *Os Hyoides*, and its basis; they lift the *Os Hyoides* and all that is annexed or joyned to it backwards, and upwards; the root of the tongue is also spread and lifted up forwards, the *Os Hyoides* pressed up to the palat, the passage to the nostrils shut, the *Os Hyoides* and larynx being by that means contracted; the *Thyrohyoidei*, rising carnos from the side of the *Os Hyoides*, and descending, are fixed by a large insertion, to the lower side of the *Cartilago Scutiformis*; which by pressing upon what is to be swallowed, prevent the epiglottis from rising, and by the assistance of its own muscles, keep it close to the glottis or chink, which opens to admit the air in respiration; they likewise throw the mucus, pressed out of the veil of the palat, the uvula, tonsils, the root of the tongue, the epiglottis and its glands, and the *Glandula Arytencides*, as well as the cavities of the pharynx, about what is to be swallowed, and move the root of the dilated tongue, the *Os Hyoides*, and the larynx forwards. The *Genioglossi*, *Myloglossi*, the *Geniohyoidei* and

*Mylo-*



*Mylohyoidei* so far dilate the pharynx annexed to the root of the tongue, *Os Hyoides*, and larynx, that they make way for the passage of what is to be swallowed, especially when the external *Pterygoidei* and some fibres of the masseters, violently draw the whole lower jaw forwards; and thus they greatly widen the passage, whilst the *Glossopharyngæi*, *Hyopharyngæi*, *Thyropharyngæi*, and *Cricopharyngæi*, at the same time draw forwards; and thus attracting the parts both ways, they make the upper cavity of the pharynx ready for swallowing, and shut its upper orifice; the *Stylopharyngei* being at the same time contracted, and the esophagus or gullet relaxed, they press down what is to be swallowed. At which time the external, and internal gargareonian muscles elevate and expand the covering of the palat, and contract the uvula; and thus the passage of any thing to be swallowed, is prevented from falling into the glottis, and eructations through the nostrils are avoided.

This being done, all the muscles that were contracted are relaxed, and both the *Sternohyoides* begin to act, which rising carnos from the inside of the clavicle near the sternum, and from the adjoining sternum it self, ascending, insert themselves into the basis of the *Os Hyoides* before; and at the same time the *Sternothyroides*, which rise from the upper and fore part of the clavicle near the basis of the *Cartilago scutiformis*, ascending obliquely upwards and outwards, are inserted into the lateral and external tubercle thereof; the *Coracoceratohyoides*, having a round fleshy beginning from the upper edge of the scapula at the root of the *Coracoides* process, discover two bellies in their progress, and are fastned to the fore part of the *Os Hyoides*, by which the broad and back part of the *Cricoides*, is pressed against the pharynx in their motion backwards and downwards, which is performed

formed with great celerity. The *Glossostaphylini*, *Pharyngostaphylini*, and the *Azygus Morgagni* are contracted at the same time, by which the face of the palat which is then much stretched and expanded upwards, is forced down; it likewise thrusts what is thus pressed forwards, down into the mouth of the esophagus, which is elevated and relaxed, the *Glossostaphylini* and *Pharyngostaphylini* being contracted: at the same time, there is a like violent contraction of the *Glossopharyngæi*, *Hyopharyngæi*, and the *Thyropharyngæi*, by which the tongue, the *Os Hyoides*, larynx, and the hinder part of the pharynx being pressed together, they also forcibly assist to squeeze the aliment into the mouth of the esophagus.

Thus the pharynx is shut, and the esophagus contracted at the same time, which rises from each side of the cricoidis cartilage, that embraces and externally surrounds the mouth of it, and so what was to be swallowed, being forcibly pressed, sticks in the cavity of the esophagus under the pharynx. The business of deglutition being so laborious, and the concurrence of so many organs, and their actions, necessary thereto, renders it subject to various accidents. But by considering the frame and constitution of all the parts concern'd herein, we may easily apprehend why dry food is so difficult to swallow; the spittle and mucus, being not sufficient to dilute and lubricate it; also why upon the uvula's being lost or depraved, a cough ensues; and why, when the veil of the palat is divided, the aliment in deglutition, is apt to come out at the nostrils.

The gullet or esophagus, is a tube formed of several membranes lying one upon another; by means of the first, which is its villous coat, and lines the inside of its cavity, it continually affords a liquor, more thick and unctuous than the saliva;



Saliva; 'tis separated from the arteries distributed through it, and lubricates the passage, renders its fibres moist and fit for motion, and defends them from the asperities of any thing that is swallowed. The next is its glandulous coat, which separates the above mentioned liquor, that is pressed out by proper vessels, into the cavity of the tube; the other side of this coat is composed of vessels, which are distributed amongst the glands, throughout the whole length, and supply it with arterial blood and spirits, and carry back what is superfluous. This is encompassed with a musculous coat, consisting internally of orbicular, and externally of longitudinal fibres: all which are inclosed in a thin membrane, that is fibrous, vascular, and spongy, or full of cells; on the back part of which, frequently about the fifth vertebra of the thorax, two glands are placed on the outside of the duct, which prepare a slimy juice, for the service of this tube.

When the longitudinal and orbicular fibres are contracted, they press down what is to be swallowed, lubricated along the slimy passage, which is dilated by what passes along it, through the mouth of the stomach, which is now relaxed and open.

The food being thus conveyed into the stomach, the upper muscle on the lower side of the diaphragm, closing the gullet which passes through it, contracts the upper orifice thereof.





## C H A P. III.

*Of the Use and Action of the Stomach ; together with the Cause of Digestion.*

**T**H E aliment thus swallowed and received into a close, moist and warm stomach, and being sufficiently diluted and mixed with air, presently begins, according to the difference of the substance therein contained, either to ferment or tend to putrefaction ; and is one way or other wonderfully changed, as, if the digestion be natural and the food good, into a wholesome and well concocted chymus ; but if that be depraved, either into an acid, austere, alkalious, acrid, rancid, or else into a glutinous and phlegmatic mass.

The internal coat of the stomach, in its concave part, is villous, unequal, full of furrows, moist and clammy ; but on its convex part, furnished with a great variety of glands, which are contained in its vascular coat, adhering to the rugous ; it is supplied with arteries from the epigastrics, and three other branches from the celiac artery, that afterwards send out a great many twigs into the cavity of the ventricle, which is plentifully furnished with veins and nerves, interwoven in a wonderful manner one with another ; besides these, it is supplied with many small twigs from the gastric arteries, all which continually



nually separate and discharge by small canals, a thin, pellucid, and frothy humor, greatly impregnated with spirits, and moderately with salt; in the most voracious creatures neither acid nor alkalious, but sharp or acrid in those that have fasted long; it is also supplied with a thick, mucous liquor, separated by the glands, and discharged by proper vessels into the cavity of the stomach.

The proper fluid of this part appears more thick and viscid than saliva, is quite insipid and without scent; nor does it ferment either with acid or alkali, or produce any change of colour in the tincture of mallow-flowers; but it turns a solution of sublimate somewhat milky; and therefore seems of the same nature with the saliva, as its uses are the same.

The stomach contracting renders its *Ruga* greater, and so prevents too quick a passage of the food, occasions the ferment to grow sharper, helps digestion, and whets the appetite. This coat being worn and extended too much, is usually wanting in voracious creatures; as is likewise that of the gullet above the ventricle, which is of the like structure, and supplied with the same sort of fluid.

Besides what is thus discharged in the stomach to mix with the contents thereof, a large quantity of saliva continually flows out of the mouth and esophagus, which perpetually dilutes what is contained in the stomach, and continually agitating and fermenting the new food that is perfectly mixed with the remains of the former, which gives a like ferment and helps to assimilate the other: this effect is much promoted by the elastic property of the air, which is intimately mixed through the whole mass. And all these actions are further excited and encouraged by the  
natural

natural heat of the part. These several means conspiring together, the contents of the stomach are thereby diluted, expanded, attenuated, fermented, digested, dissolved, and made like to the juices of the body, and fit to pass through all its fine and curious canals and minute vessels.

But this does not explain how the more solid food, without much mastication or comminution, is digested: to account for that, we are to consider farther, the musculous fabric, and conformation of the stomach. It appears from hence, that the carnous coat, covered with that of *Ruysche*, which supplies the stomach with an oily substance, consists of very strong fibres in its convex part, which, being continued from the upper orifice down to the pylorus, in an orbicular or spiral order, encompass the whole cavity, in a perpendicular posture almost the whole length; these contracting, make it narrower and diminish its breadth. The concave part consists of fibres first oblique, contracting the bottom of the stomach obliquely towards the back part of it, and also its upper orifice, by this means diminishing its length; the second order are also very strong, and embrace the whole length of the pylorus, and unite at the back thereof; they also encircle the upper orifice, and so, when the stomach is empty, draw the mouths of its orifices nearer together; but when it is full, distended, and hindered from contracting, they chiefly press the pylorus strongly.

This coat is not only covered with the just mention'd cavernous one of *Ruysche*, but also with another externally, which, in the convex part, is very full of vessels; and in the concave of fibres in a longitudinal direction, which when contracted help to shorten it.

These



These fibres, though greatly disposed to contraction, are not sufficiently able to empty and discharge the contents of the stomach ; when they act together they shut up the orifices of it, and press the contents which distend it, forcibly together, which helps to mix them; and, by their vermicular motion, they rub and grind them, by striking the parts one against another ; they also retain what is gross in the stomach, and attenuate the same; afterwards squeezing the thinner part into the sinus that lies before the pylorus, and ascends perpendicularly, when by means of the strict constriction thereof, the native internal thickness of the part, and its reflex position towards the back, now conspiring in the action, the aliment herein contained, receives a tendency towards the duodenum, reaching to the cavity of the pylorus, which now being not so firmly closed as the upper orifice of the stomach, that is, much higher than it, the chymus, before squeezed down to the lower orifice of the stomach, being reduced into a fine and attenuated mass, is, as well as the fluid part before, gently and gradually pressed into the duodenum.

Some creatures only have this contractive and expulsive force of the stomach, but perhaps a little more violent, to digest their aliment. In some also this motion may be heard ; in others it is demonstrated by the effects ; and the nervous and musculous fabric of the parts demonstrates the like in us, if we allow the force of comparative anatomy.

From hence we may learn the reason, why the stomach, when but little is taken in, grows empty so soon ; and why, when it is too much distended, nothing passes through it, but after it has been long retained tis vomited up again, crude and indigested ; and also why liquors

quors are retained, when hastily drank, and in large quantities.

These causes, 'tis true, may seem insufficient to digest all the contents of the stomach: but if we consider the continual heat of the ambient parts; the innumerable and constant pulsations or strokes of the arteries of the stomach, diaphragm, omentum, spleen, liver, pancreas, mesentery and peritoneum; the strong and continual vibrations of the great artery below it, and the force of the nervous juice, which is scarce more plentiful in any part; the continual, reciprocal and strong compression almost of the whole peritoneum, by means of the diaphragm, which rising on the lower and right side, from the three first *Vertebrae* of the loins; and, on the left, tendinous from the last and last but one of the thorax, but presently growing carnous with direct fibres, that soon become tendinous again: that on the upper part 'tis thin and membranous, but presently becomes carnous, from the whole margin or edge of the cartilaginous ends of the lower ribs, and the lower part of the sternum, with fibres which tend to a center, ending in a tendon and uniting with the former; that this, acting from a convex position to a plain one, compresses and contracts the abdomen and the contents thereof; if we likewise consider that the ten muscles of the abdomen, with their reciprocal motions and united contractions, strongly compress and contract the abdomen, and have a vast force upon it; as observation informs us: for, first, the external oblique muscle, rising tendinous and carnous from the lower end of the ribs, and, descending, ends in a broad tendon expanded above the *Recti*, the internal oblique muscles, and the transverse, and ends and is inserted in the whole *Linea alba*, the *Os Pubis*, and  
the



the fore and upper edge of the *Os Ilium*; next, the internal oblique muscle rising fleshy from the circular edges of the *Os Ilium*, and the ligament of the *Os Pubis*; and consisting of fibres tending forwards, upwards, horizontally, and downwards, is inserted tendinous into the *Linea alba*, and the cartilages of the five lower ribs: the pyramidal, rising fleshy from the fore and upper part of the *Os Pubis*, end in a tendon that is inserted into the *Linea alba*, and navel; the transverse having a carnous beginning from a tendinous expansion, fixed to the transverse processes of the *Vertebrae* of the loins, the spine of the *Os Ilium*, the ligament of the *Os Pubis*, and the cartilaginous ends of the ribs below the sternum, terminate in a broad tendon, all along the *Linea alba*, under the *Rectus*: the *Rectus* beginning fleshy from the *Cartilago Ensiformis*, the cartilages of the two lower true ribs, and the cartilages of the two upper bastard ribs; and, being divided into five tendinous parts, which grow carnous again, is at last inserted into the upper and fore part of the *Os Pubis*.

I say then, if we consider the united force of all these concurring causes, acting upon the mass of food contained in the stomach, which is not only sufficiently soften'd, and disposed to be dissolved, but closely confined and compressed together; it will not be difficult to conceive how the action of digestion is performed.

And *first*, we see how the parts of the aliment that are conveniently chew'd, ground, and apt to be put in motion, may be mixed, levigated, and dissolved with the fluids; and, putting on the form of a grey-colour'd pulp, may be pressed out gently at the part which nature design'd should admit of its discharge.



*Secondly,* How the grosser and less digested parts, which are left somewhat crude and unfit to go through, may be retained; and, by a continuation of the above mentioned causes, undergo the same alterations, and be digested and prepared for a like discharge with the former.

*Thirdly,* How the fibrous, membranous, tendinous or cartilaginous parts, as well as the bones, skins and filaments of animals, and the grosser parts of vegetables, may be drained of their juices and nutritional parts, and at last expelled the stomach.

*Fourthly,* How, by a dissolution of the parts of vegetables, and animals, a liquor may be extracted and assimilated, so as to be converted into a liquid, fit to nourish and preserve a human body.

*Fifthly,* How bodies, weakned and debilitated by long abstinence, are suddenly restored from their languid state; the more subtil and rarified fluid, being thus received by proper vessels or canals, which on every side discharge themselves in the mouth, esophagus, and stomach; which, being thence presently conveyed into the blood vessels, and distributed by the arteries through all the parts of the body, quickly supplies what was deficient, and refreshes the whole.

From what hath been said, we may see how far the heat of the stomach may contribute to promote digestion: whether the action of it be assisted by a natural acrimony; or whether that be encouraged by an acid: why a gross, saline, acid or bitter humor, is often belched up by a healthy man, when his stomach is empty; especially if he stoop forwards: whether the appetite or disposition to hunger, proceeds from several causes, and what they may be; as also, why sometimes the stomach is swelled or tumified.

It appearing then, that these parts naturally separate a thin serum, or saliva, to dilute, and a

mucous



mucous juice, as well as a fat unctuous substance, to lubricate and promote the passage of food into the stomach; and that even in the stomach, a thin spirituous saltish liquor, is also separated, as well as an oily mucilage; and that these are all confounded together by the motion and compression of the parts; it will follow, that not only such motions and compression, are necessary to promote digestion, but that such fluids are requisite to perfect natural concoction, as are endowed with the above-mentioned qualities, *viz.* saltish, spirituous, oily and mucilaginous, which, united together, like a proper menstruum, not only help to dissolve the contents of the stomach, but also the more volatile parts, by dividing and rarifying, attenuate and ferment whatever is therein contained, if properly diluted: and this effect must needs be forwarded, not only by the assisting motion of the parts, but the accession of subtile effluvia, excited by the heat of the ambient parts, which promote the intestine motion of the confined matter, especially such portions thereof as are most susceptible of motion, and disposed to ferment; and this, consequently, helps to divide, dissolve and subtilize the grosser parts. The like separation is also promoted by the air included, which is easily made to expand and rarify:

And as this saline, spirituous, and oleo-mucilaginous fluid, promotes digestion, and performs the works of nature; so, in a preternatural state, it produces preternatural effects; in a natural state by twitching the nervous fibres, it occasions a natural appetite, and assimilates a homogeneous liquor; but when vitiated and depraved, it corrodes too much, and perverts the contents of the stomach, into an heterogeneous liquor of various qualities.

When the stomach is almost empty, it contracts and falls together, and only retaining some grosser



parts, the pylorus being now enlarged, these, by the force of respiration, are more easily pressed out; yet it is seldom so far emptied, but that something remains behind, which, being further rarified, digested, and mixed with new food, helps forward and quickens the concoction of fresh supplies.



#### C H A P. IV.

*Of the Action of the Intestins, with their Use in Chylification: As also of the Bile and Pancreatic Juice.*

**T**HAT we may understand what is done in the intestins, and how the chyle and feces are separated from the chymus prepared in the stomach, we must consider their fabric and structure; what juices are laid down therein; what vessels receive any fluids from them; and likewise their motion, with that of the parts which lie about them.

The first coat of the guts, and which immediately contains the chymus, is villous, rough, and full of protuberances, or minute, grey *Papillæ*; 'tis large, and perforated by tubes, that carry, some of them, watry, others glutinous liquours; and also by the mouths of the lacteal vessels, and large pores distinct from these. It is always moistened and made slippery, with a watry and slimy juice, and is joined to the nervous coat; but 'tis three times longer than that, especially in the gut called jejunum; where



where rising up in duplicatures, it forms several valves, called *Valvulae conniventes*, and is full of wrinkles, especially at its connection with the mesentery; its convex part, or outside, is full of glands, vessels and nerves. These valves and wrinkles prevent too quick a passage of the chyle and feces, and are continually moistened and made slippery, to defend the inside of the coat, and dilute the grosser matter; but especially about the end of the ilium, where the oily part makes the grosser feces pass the easier. Their acute sensation, when twinged with any thing sharp, promotes the peristaltic motion of the guts, and, causing a constriction of the mouths of their vessels, obstructs the admission of such humors as are hurtful to the body.

This coat is encompassed by another, which is very thin, and continued along with it, except in its valves; it consists of innumerable arterial branches, interwoven like a net, which terminate in a soft substance, like the weak brush-end of a pencil, partly in the *Peyerian* glands, and partly in excretory ducts, distributed in the cavity of the intestines; it is also furnished with veins, which either answering the arteries by anastomosis, as a continued duct, are inserted in the *Peyerian* glands, or open into the villous coat; 'tis moreover furnished with nerves, which almost adhere to the roots of the *Peyerian* glands, and are purposely placed under the musculous coat of the intestines, and their mouths, opening through the villous crust, supply it with a mucus. These are very few in number in the beginning of the small guts, but gradually grow larger, more numerous, and appear very plentiful at the beginning of the thick guts; their office is to dilute the feces, lubricate and moisten the parts, defend them from asperities and acridities, and to allay the heat.



Next to this is the muscular coat, consisting, on the inside, of firm and strong annular fibres, inserted into the edge of the mesentery, as into a tendon; by these the whole cavity of the small guts is successively contracted, the valves at the same time rising up; and the contents are reciprocally pressed upwards and downwards, against the sides of the villous coat; being by this means ground, mixed, attenuated, and hindered from adhering together. The sides of the intestins are also hereby deterged, the convex or outside being composed of longitudinal fibres, which intersect the former, whereby they are corrugated and contracted, and the intestins streightned; especially on those sides opposite to the region of the mesentery.

There is another muscular coat, lately discovered by *Ruyfche*, which, being membranous and full of cells, is very serviceable in supplying the muscles of the intestins with fat, as they are constantly in motion; it is the seat of a great many distempers in the intestins, but is scarce perceivable in lean persons; the outermost, which encompasses the former, rises from the peritoneum; but that encloses the rest, keeps them in their places, strengthens the vessels, and ties them fast together.

The whole continued gut fixed to the wrinkled edges of the mesentery, is thereby suspended, and being folded up in wreaths after different manners, tis all made slippery, and cherished as well as softened, and rendered fit for motion by the fat omentum, which lies thereon; and running betwixt its several parts, emits comfortable exhalations of an oily nature, greatly attenuated by the continual motion of them, as appears from experience; and by this means it is prevented from adhering to the peritoneum, or the intestins. It is exposed



fed to the peritoneum in those places where the most frequent reciprocal motions happen the surrounding causes. In a natural state it only contains what is diluted, growing thicker at the end; when full, it is much streightned, and agitated continually by the peristaltic motion; which renders it most fit for grinding, diluting, separating and volatilizing the chyle; and, when duly digested and dissolved, to force it into the lacteals. The structure of this intestin also adapts it to retard too sudden a motion of crudities, and such liquors as are not sufficiently digested; to which end the curved and winding passage of the gut also contributes.

That part of the intestins called duodenum, is naturally streight, narrow, and fixed to the back by help of the process of the omentum; it is perforated near the end by the common duct of the bile; and also by *Wirsungius's* pancreatic duct, which is sometimes single, but often double, either separate or joined close together; and therefore the passage of the chyle is quick here, though less digested. From hence it appears, that this gut receives three kinds of fluids; namely the chymus, from the stomach; the bile and pancreatic juice.

The jejunum rises from the end of the duodenum at right angles, and, going back therefrom, occasions a stoppage of the chymus, bile, and pancreatic juice, till they be mixed and further digested.

The choler, or bile, deposited in the duodenum, is either cystic, or hepatic. That from the gall-bladder is thickest, more bitter than the other, and of a deeper yellow. It does not constantly run into the intestins, but flows out plentifully, when pressed by the muscular coat of its bladder. The hepatic bile is thinner, clearer, not so



bitter, and flows constantly; being pressed out by the force of circulation and respiration. The pancreatic juice also flows almost continually. These juices, along with the saliva and mucus of the mouth, œsophagus, stomach, and intestins, being mixed together, form a thickish frothy liquor, which, lodged in this gut, is often pressed back again into the stomach.

The bile, thus mixed with the chyle, prevents it from growing sour, and impregnates it with the like qualities it self retains. It is of a lixivious nature, deterges, disposes oil to mix with water, attenuates resinous substances, and dissolves them; it also promotes assimilation, and preserves the union of bodies already mixed. It is neither alkali nor acid, but contains oily, saline, spirituous parts, diluted with water; being the sharpest humor in the body, and combustible when dried.

Its activity and penetrating nature appear from penetrating thro' its including coats and membranes, and tinging the side of the stomach opposite thereto; as also the colon yellow. Acids will coagulate, and alkali's liquify the bile. A microscope represents it as a multitude of filaments interwoven with each other, and variously transfixed by small rigid particles, all swimming in a pellucid fluid. When chymically analysed, it affords a large quantity of whitish phlegm, of an oily urinous taste; an urinous spirit, differing only in its larger quantity of salt from the former; a fetid black oil, containing an urinous salt; some fixt salt; and a little earth, scarce differing from a mixed elementary body.

The use of it, when mixed with the chyle and feces, is to attenuate, dissolve and cleanse; also, by stimulating the fibres of the intestins, to promote the peristaltic motion, and dispose every thing to unite and mix; it likewise blunts and corrects the sharp  
acid



acrid qualities of salts, and, like a menstruum, dissolves what is coagulated; it moreover, prepares the chyle for separation, and promotes the same by exciting the contractive and peristaltic motion; it further, acts as a ferment, promotes digestion and the concoction of crudities, by assimilating them with what is already prepared. The effects of that in the gall-bladder are much stronger, than the other, this being improved by a further digestion, and long detained in its reservoir; whereas, the latter is discharged as fast as separated in the liver: but more of this, when we come to treat of the liver, and its use.

The pancreas, is situate at the back and right side, under the bottom of the stomach, in the hinder part of the duplicature of the omentum, being a large conglomerate gland; and lying close to the duodenum, it continually separates from the celiac arteries, a limpid, almost insipid, but somewhat saltish liquor, which is discharged into the duodenum by one common duct. 'Tis secreted in great quantities, and forced out by the motion and pressure of circulation, and the parts adjacent, especially by the stomach, which lies upon it when full. It is neither acid nor alkali, but partly resembles the saliva, both in respect of its nature, the vessels wherein 'tis separated, its qualities and appearances. When mixed with the bile, and digested with it in the same gut; it produces no sensible fermentation, but is united with the whole, or discharged alone into the cavity of the intestines; so that when blended with the chyle and feces, it seems chiefly designed to attenuate and dilute. It also thins the mucus, and may in some measure correct the acrimony of the chyle, which it helps to temper, and prevents too great a stimulation of the muscles of the intestines; and consequently it hinders too quick a passage of the aliment

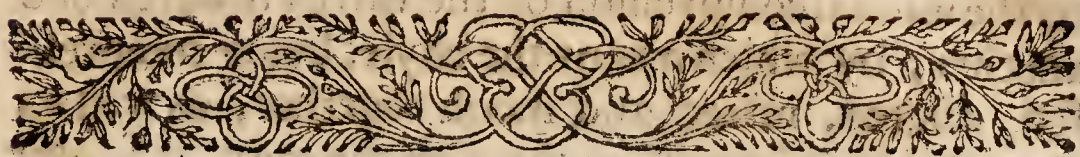


aliment into the jejunum. It also contributes, by diluting, the mixture of the whole, and by attenuating the chyle, to render it fitter to pass into the lacteals, as well as through them. It also disposes the same to mix with the blood; and as it may contribute to allay the acrimony of the bile, so it abates its visciditv and bitterness, serves to alter its colour, and mix it more thoroughly with the chyle. It may likewise serve, not only as a vehicle, but a menstruum; and so alter the taste, scent and other qualities, as well as its disposition; and moreover help to assimilate and dispose the serum, to separate in the pancreas again, to continue a supply of the same liquor.

From hence it appears, that bile is of two kinds; and how far it is to be esteemed an excrement of the liver; how far it is serviceable in preserving health; and continuing the actions of life, necessary to afford the body a constant supply of nourishment; how much the bile and pancreatic juice contribute to lay the foundations of fermentation, and assimilation; to excite and dispose the fluids thus prepared to be fermented in the blood; and to promote a fermentation therein; what is the use of the pancreatic juice; why it flows along with the bile; and how far it tends to the preservation of life.







C H A P. V.

*Of the Passage of the Chyle into the Lacteal Vessels. Of the Substance of the Feces, and their Expulsion. Of the Use of the Mesentery, and the Mesenteric Glands, in respect of the Chyle : As also, of the Ductus Chyliferus, or Pecquetianus.*

**W**HEN the strait fibres of the intestins, inserted into the external coat, as into a tendon, are contracted, the gut becomes rugous on the part opposite to the mesentery, which reduces it from a spiral to a cylindrical form; this makes it loose on the side next the mesentery, but contracts it on the opposite one; by which means the small orifices of the lacteals, that lie next the mesentery, are so dilated, and adapted to receive the more fluid, diluted and soft parts of the chyle, that they readily enter in thereat: in the mean while, the *Valvulae conniventes* are raised up by the same contraction, and drawn nearer to one another, and so intercept and stop the motion of the chyle through the intestins, which are closely shut by those contracted valves.

The orbicular fibres, inserted into the mesentery, being at the same time contracted, the cylindrical



drical intervals of the tube are lessened, and kept close by the mutual compression of the valves towards one another; by which means the chyle, being compressed, diluted, mixed and shook together, as well as intercepted in its passage through the guts, it is, by the force of the ambient parts, chiefly propelled and pressed towards the proper places in the mesentery, and driven into the mouths of the lacteals, which are thus prepared, together with the peristaltic motion, and made ready to receive it.

From hence it appears, that the chyle, received by the mouths of the lacteals, is not only composed of solid and fluid aliment, but also of saliva, a thin mucus separated in the mouth, a compound liquor from the esophagus and stomach, another from the gall-bladder and hepatic duct, the pancreatic and lymphatic juice separated in the intestines, the *Peyerian* liquor pressed out of the glands in the same, and likewise a most subtle liquor that ouzes out of an infinite number of nerves; for all these humors, that are either swallowed or separated by the way, and mixed with the chyle, pass continually into the lacteals; though those vessels only appear after a large quantity of food has been received. The chyle is sweetish to the taste, grows acid by keeping, and coagulates with acids; but becomes more liquid by mixing with alkali's, and greatly resembles milk. Through a microscope it appears to be numberless spherical globules, swimming freely about in a thin aqueous fluid.

The thin and bilious, as well as lymphatic parts of the chyle, are received by the open mouths of the lacteals, and conveyed into the meseraic vessels; and passing, according to the laws of circulation, into the branches of the *Vena Portæ*, and, being sufficiently diluted, afford or prepare fresh matter for the separation of the bile: and thus all  
these



these juices continue in a constant course of circulation to furnish and perfect the whole machine: The great number of these vessels, their large size, peculiar conformation and structure, the particular structure of every distinct vessel, the general use of all veins, the different fluid flowing from each canal, the venal blood thrown into the *Vena Portæ*, sa into an artery; and, besides all this, the vast quantity of humors flowing into the intestins, which are neither all received into the lacteals, nor expelled as excrements; comparative anatomy, likewise, which discovers no lacteals in oviparous creatures, but particular passages in their stead, that run from the cavity of the intestins into the meseraic veins, and answer the same purpose: all these things, I say, shew what wonderful contrivance there is in preparing the nourishment, assimilating and rendering it fit for the uses of nature, the preservation of health, and continuance of life.

And when all the phenomena, observed from the first assumption of the aliment into the mouth, to the entrance of the chyle into the lacteals, are thoroughly considered, and demonstrated to proceed from the fabric and force of the vessels, the known qualities of the fluids, and their virtues, discover'd both by sense and mechanical reasoning; there is no occasion to fly to obscure and uncertain hypotheses, or unnatural experiments, to account for what nature alone, when well considered, will lead us to the knowledge of. We need not postulate, that the heat of the stomach is the cause of digestion, or attribute the works of nature to natural, vital and animal innate heat; or alkalious bile, to change fixed acid chyle into a volatile alkalious salt; nor need we make use of a fictitious acrimony, in the pancreatic juice, to cause a ferment with the alkalious bile; or of precipitation to separate the feces and cleanse the chyle: of no more service are the



the *Peripatetic* faculties, or the *Galenical* and chymical effervescences and fermentations; since mechanics alone suffice to explain all the operations in human bodies.

The thicker portion of the chymus, being too gross to pass into the lacteal vessels, and not sufficiently attenuated, either by the action of chewing, or chylication, is, after the admission of the thinner part, which was pressed thereinto by the peristaltic and other motions of the guts, with the assistance of their valves, farther comminuted and compressed by their circumvolutions, continued thirty seven hands in length; the guts being all along lubricated and moistened, with a fat substance separated from the glands. This gross part then is gradually drove into more confined and narrow passages, where 'tis more pressed, ground, diluted, digested, softened and successively squeez'd into the lacteals, till the liquid part be almost wholly imbibed and exhausted; when the remainder is thrust out at the end of the ileum, almost perpendicularly into the left part of the gut call'd *Cæcum*, which, opening ready to receive it, is afterwards closed up by a valve, fixed to the sides thereof, by means of a muscle that shuts it, and so prevents the regurgitation or reflux of the feces. And thus the grosser parts of the aliment are discharged into the cavity of the *Cæcum*.

After this discharge made into the *Cæcum*, a small vermicular gut, furnished with a valve, first discovered by *Tulpius*; and, which prevents a communication betwixt the *cæcum* and the ileum, only admits any thing out of the latter into the former; it ascends into the beginning of the colon, that is at first perpendicular; for which reason the feces are less apt to return into the ileum, and and being here some time detained, and strongly compressed, not only by their own weight, but the



contraction of the gut and the parts adjacent, they are wholly deprived of the liquid part; which being received into the lymphatic vessels, and discharged into the lacteals, they at last form a dry, hard, solid excrement, tending to putrefaction, and different from the contents of the other intestins. The colon is furnished with many large valves, which are contracted by three muscular ligaments, that strengthen the fibres, and help to contract and assist the gut, that would otherwise be too weak, upon account of its bending, largeness, and length, which is near eight hands, to occasion a stoppage of the feces, and allow them sufficient time to be collected, detained, dry'd and putrefy'd; but now the strong musculous coats, being irritated and contracted, force the hard, and otherwise immoveable feces through the gut, moistened and made slippery, as I said before, by an unctuous fat substance from the glands.

The feces are thus forced perpendicularly into the gut, called rectum, the inside whereof is very slippery, and without valves or muscular ligaments, which renders their descent quick and easy; they also irritate this intestin by their bulk, or acrimony, or both. The coats of this gut consist of strong longitudinal fibres, rising from the expanded, concurring ligaments of the colon, which embrace the whole outside of the rectum; and, joining the two intestins together, they streighten and contract the gut in length; wherein they are assisted by spiral or circular fibres, whereby the feces are driven down even to the *Sphincter Ani*.

The sphincter muscle being relaxed, which is large, thick, fleshy and orbicular, and embraces the end of the rectum, the *Levatores Ani* are contracted. These muscles rise from the inside of the *Os Pubis*, *Ischium*, and *Sacrum*, and are composed



posed of curve fibres, which, terminating in the end of the rectum, dilate and lift it up; then the *Pelvis* being pressed and contracted, by the assistance of air breathed in, retained and rarified, and a compression of the thorax, as well as of the diaphragm, and the contraction of the muscles of the abdomen, all the other parts are relaxed, and the feces pressed out; being first mollified by a plentiful separation of an oily mucus, discharged by the glands, seated thereabouts for that purpose; after which the sphincter muscle alone is violently contracted.

From hence we may learn, what the feces consist of; whether of the superfluities of the bile, blood, mucus, saliva or lymph, or not; and what is the chief cause thereof; or, whether they proceed from a fermentation, occasioned by the feces before contained; as also, whether the intestins have the greater number of glands, and quantity of mucus, the nearer they grow to the extremity; what service the fat does to the guts, which is continued every where, but more plentifully about the end thereof; why, in strong people, the feces are hard, light and few; and, why such are often troubled with the hemorrhoids; why the urine is commonly forced out at the same time with the feces; why those, who have a stone in the bladder, are subject to a tenesmus; why a dysentery and strangury often happen together; and, why a strangury is attended with a tenesmus.

The chyle being, as we said before, driven into the mouths of the lacteals, it is propelled forwards therein by the helps already mentioned, and the continuance of the very same motion; but since the lacteals open, as 'tis plain they do, obliquely into the intestins; since the mouths of them are exceeding small; since they pass through the muscular coats, and are presently united in large vessels



vessels or canals under the outward membrane, that encloses the intestins, and so proceed towards the mesentery, into which only the more fluid and white chyle can pass, which is first separated from the more gross and viscous part, that is of a brown, dusky, or a yellow colour; it appears, why a great variety of acrimonious, hard, and sharp things that are swallowed, prove inoffensive to human bodies, and no way prejudicial to health; and if we compare the structure of the esophagus, the stomach and intestins, with that of the other viscera, they appear very different, as, for instance, the largeness of the cavities of the intestins, with the narrow orifices of the lacteals, in which, as well as in their contents, there is a vast disproportion; not to mention the aptness of the small sphincters, to be contracted by sharp particles of matter, which closes the orifices of the lacteals, and guards them from the too easy admission of such humors.

The several conspiring causes which force the chyle into the lacteals, still continuing, promote the constant propulsion of fresh chyle, and press what was before received, still forwards, and force it into the vessels in the duplicature of the mesentery, where it is detained by semilunar valves, and hindered from flowing back again; and thus its progressive motion towards the loins is promoted and continued.

The lacteals, which are very small in their origin, unite and meet together in acute angles, and thence flow in a greater stream. These branches are again separated at a greater distance, and being re-united in a gland, afterwards join in a common channel; and being in their progress again united, form still larger vessels; all which are furnished with several valves, to hinder a reflux. By this means the chyle is more perfectly

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mixed,

mixed, attenuated, and rendered fluid. These are called lacteals of the first kind.

The lacteals are thus distributed, some in right lines, others in oblique ones, variously intersecting one another, into the glands every where dispersed through the mesentery; and meeting together in these soft glands, through which they are distributed, they are again continued from them in larger branches, being distended, and full of a more diluted chyle. They are also furnish'd with valves to hinder the reflux thereof. These vessels, tending towards the large gland in the mesentery, called *Receptaculum chyli*, or the store-house of chyle, are called lacteals of the second kind. Whence it appears, that nothing is separated from the chyle in these vessels, but that it is diluted and rendered more thin and fluid as it passes thro' them.

And that the chyle is thus diluted in the glands of the mesentery, will more evidently appear, if we consider, that these glands are every where supplied with single arteries, not conglomerated; as also with nerves, and abundance of lymphatic vessels, which supply them with lymph from several of the viscera in the abdomen, which help to dilute the chyle; and by a thin humor separated from the extremities of the arteries dispersed through these glands, promote and accelerate the motion of the chyle through the vessels, and not only dilute, but attenuate the parts thereof, by grinding them together. It is also further attenuated and rarified by the additional force of the spirits, separated from the nerves.

The lacteal vessels being yet again united into larger branches, terminate in the *Receptaculum chyli*, in a triple orifice, whereinto a lymph is plentifully discharged from all the parts below the diaphragm, which not only further dilutes it,  
but



but serves also to accelerate and quicken its progressive motion. And that this is the use and constant motion of the lymphatic juice and chyle, appears, from the valves contained in the lacteals, and the experiments made with ligatures, as well as the diseases consequent upon the preternatural discharges of the lymphatic juice.

This juice consists of the most aqueous and spirituous part of the arterial blood, and is impregnated with the most volatile salts contained therein, as appears from the manner of its separation, the vessels wherein it is separated, and its own evident qualities.

The ancients, were only acquainted with two universal humors, the blood and animal spirits; they knew nothing of a limpid, thin, watry fluid, secreted in all the parts of the body. This liquor is almost insipid, clammy when cold, but does not, like blood, coagulate in the air; the fire, by evaporating, soon reduces it to a little whitish calx: spirit of nitre thickens and turns it white, but oil of tartar restores its former liquidity. It also turns a tincture of mallow-flowers green; and therefore appears to consist of much phlegm, a little sulphur, and less volatile salt.

The chyle, being thus diluted by the lymph, discharged and separated from the parts under the diaphragm, is not only, by the causes already mention'd, but more especially, by the pressure of the diaphragm, and the pulsation of the aorta, drove into the thoracic duct, discovered by *Pecquet*, which is full of valves, to hinder its regress, and terminates in the left or right subclavian, near the insertion of the jugular vein, where it is furnished with a semilunar valve, which admits the passage of the chyle into the vein, but hinders the regress of any thing into the thora-

cic duct. This duct is of a viscous, membranous, and musculous substance, and supplied with lymphatics from every part of the thorax.

And for these reasons, the chyle and lymph, which are discharged plentifully by this duct into the subclavian vein, are easily conveyed thro' this perpendicular tube, and all its divarications, when a man is in an erect posture. And if we consider the contractive power of the intestins, the assisting force which accelerates the motion of the chyle, the conveniency of the valves of the lacteals, the common receptacle, and of the thoracic duct, which facilitate its motion, and render its passage more commodious; and likewise the pulsation of the meseraic arteries, which are either parallel with the lacteals, or lie a-cross them; the great pressure of the diaphragm, and the constant action of the peritoneum, which is performed with some force upon the membrane of the mesentery, containing these lacteals; and further, if we consider the great contractive force of the membranes, that compose the thoracic duct, which remains strong even after death; and the arterial force and pulsation of the aorta, which lies near the same, together with the motion of the lungs and thorax, it will not be difficult to imagine how the quick passage of the chyle is promoted, carried on, and perpetuated.

The effects then upon the chyle, in its passage, betwixt the intestins and veins, seem reducible to these four heads.

*First,* Its motion through the intestins, lacteals, and glands; the length of the former relaxed, and the minuteness and number of the latter, help to purge, cleanse, and separate the grosser unconcocted parts from the more pure and digested.

*Secondly,*



*Secondly*, The impression of external motions on the vessels and fluids contained in them; which promotes their passage through the vessels, their mixture, attenuation and fluidity; where we should consider the position of the lacteals, which are gradually enlarged, furnished with valves, and united with one another, then separated, and again united; also the strong compression of the diaphragm, and muscles of the abdomen, and of the bowels which press upon the lacteals, placed in the superficies of the mesentery, with little to cover them; likewise the degrees of heat and moisture, most apt and convenient to promote digestion, and produce effects that are well illustrated by chymical experiments. To these we may add the continual pulsation of the meseraic arteries, and the aorta, which almost perpetually accompany the lacteals, and strike against them in their continual vibrations.

*Thirdly*, To dilute the chyle, almost all the lymphatics concur throughout the abdomen, and the thorax; besides the moist exhalations which serve to bedew their cavities, and which are chiefly imbibed by these lymphatics; to which also the spirits much contribute, being mixed with the lymph in the conglobate glands, and infused into the chyle.

*Fourthly*, It is assimilated with all the parts of the body, before it is conveyed into the blood; for in its whole passage, even from the mouth, till it is discharged into the subclavian vein, it is gently, gradually, and successively supplied with a different humor, elaborated and digested almost in every part of the body, and forced thro' all sorts of vessels; as the saliva and mucus of the mouth; the lymph and mucus of the esophagus, stomach and intestines; the pancreatic juice, and both sorts of bile; the lymph of the

whole body, and likewise spirits from all the minute branches of the nerves: it is also mixed by the united force of the whole machine, which contributes to these effects, from the figure, situation, and motion of its parts.

If we look into, and examine the substance of the chyle, when 'tis arrived thus far, we shall find in it all those principles which compose blood; as water, spirit, oil, and salts, perfectly mixed, and united together.

Nor is it surprizing, that distempers seldom happen in the mesentery, tho' it seems exposed to crudities; since so great caution is taken to prevent them.

The lacteals, and the thoracic duct, serve not only to carry lymph, but spirits also; and perhaps promote the motion of the chyle.

When the chyle is mixed, and circulates with the blood, that we may understand the motions thereof, and what alterations it undergoes, we are next to consider the circulation of the blood, wherewith it is mixed, and the effects thereof.



## CHAP. V.

*Concerning the Structure of the Arteries and Veins; with the Circulation of the Blood.*

THE red fluid, called blood, is distributed thro' almost all the parts of the body; 'tis contained in proper vessels, called veins and arteries,  
or



or other intermediate receptacles, which communicate with them, especially in a healthful state.

The arteries, are tubes, or canals, of a conic figure, oblique, crooked, and divided into several branches; smooth on the inside, and without valves, except in the heart. The branches which rise from several parts, spring in acute angles towards their extremities, and are very seldom strait, as the intercostals, or obtuse, as the umbilical vessels of a fetus. They consist of five coats; the most external, is, on the outward surface, thin and nervous, but internally consists of a thick net-work of vessels, or small twigs of arteries, from the coronaries and others, interwoven with veins; the second, is thin, and full of cells or cavities, and apt to extend when those cells are full; the third, is glandulous; and the fourth, muscular, consisting of annular fibres, closely connected together, in several lays one above another, divisible into several plates, of an elastic nature; the fifth, and innermost, is thin and membranous, consisting of longitudinal fibres, which are apt to contract. The whole vessel, in health, is vigorous, moves and beats: its extremities are variously formed; so that in some parts of the body, the ends of the vessels have much wider orifices, than in others; they differ also in the thickness of their coats, the number of branches, and their windings; they are likewise variously interwoven, and divided. Sometimes the extremities of the arteries end in anastomoses, or open mouths, which continue them to the veins, without any cavernous medium; or else they are distributed into excretory vessels, or form some particular sinus's, as in the *Penis*, *Clitoris*, and spleen; or into secretory glands, or vessels, serving to the like purposes with them.

The veins, which are generally of a like figure or formation, run along with the arteries, but are

larger, and more numerous, tho' less active than they; consisting of thinner membranes; they are furnish'd with some valves, of an oblong form, and single, and much like the finger of a glove in shape, seated about the insertions of the smaller branches into the larger vessels, and commonly double, being joined together in the strait passages or trunks of the larger vessels, at some distance from the heart, and stopping the regrefs of the blood in its perpendicular passage upwards; they are so formed, and fixed to the cavity of the vessels, as to admit the blood out of the small vessels into the large ones, but hinder its regrefs when the heart is contracted, and bear up the weight of it from pressing back into the smaller vessels. These vessels neither contract nor beat, but terminate variously as the arteries; their extremities being either rooted in the absorbing pores of the skin, or those placed in the internal membranes; or by inosculation with the mouths of the arteries; or much after the same manner as in the penis, clitoris, and spleen; or else in the pulpos substance of the glands.

Whatever arteries are found in the body, they all join and communicate with the common trunk of the aorta, which rises from the left ventricle of the heart. But those which are branched through the lungs, rise from the pulmonary artery, or the *Arteria venosa*, that springs from the right ventricle of the heart. This is demonstrated by injecting these vessels with wax; though the ancients discovered it without that art, but could not trace them to their extremities.

The veins in the whole body, are likewise discharged into the *Vena cava*, which forms a large sinus, encompass'd with a membrane, much like that of the aorta, and ends in the cavity of the right auricle of the heart; and partly in the  
right



right side thereof; and the veins, which form the lungs, being joined together in four large branches, these united terminate in a like sinus with the former, which reaches to the left ventricle and left auricle. But there is some difference in the liver, which receives the branches of the *Vena Portæ*; to be mention'd when we come to treat of that part. Both these vessels are largest in the heart, and, from thence, gradually grow less, and accompany one another in all their ramifications throughout the body.

The whole mass of blood, is soon, and with great force, discharged out of the body, at a large wound in any considerably artery; which shews, that all the blood is moved very quick, and with great force: this becomes more conspicuous, if the other arteries, which are not wounded, be stop'd by ligature; which manifests a communication of the arteries, and a free passage of the blood into each of them: and, since it thus flows out of a vessel when wounded, it must needs pass through the same when it remains unhurt.

Again, if any of the arteries be laid bare, and a ligature applied thereto, it swells, beats betwixt the ligature and the heart, grows empty and flaccid betwixt the ligature and the extremity of the body, and, at the same time, the arteries adjacent beat more vehemently; and if it be opened betwixt the ligature and the heart, the blood flies forcibly out, and the animal presently dies; and if cut, betwixt the said ligature and the extremity, only a few drops of blood will come out; but the artery thus to be tied, should be single, and have no immediate communication with another branch, by anastomosis, above the place of the ligature.

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From hence it appears, that the blood flows through the arteries, in a constant course from the heart, towards the extremities remote therefrom; and into the small and finest capillaries, both in the external and internal parts of the body; out of the larger into the narrower, and more minute vessels; and thus the whole mass of blood may be drawn out of any one branch, but not the contrary way.

If you lay a large vein bare, and tie it with a thread, it swells betwixt the ligature and the extremity, does not beat, grows empty betwixt the heart and the thread; and, if pricked between the ligature and extremity, the blood flows out presently, till the animal die, or faint; but if opened above the ligature, it scarce bleeds at all; and the case is all the same, which vein soever be open'd. Whence it appears, that the blood flows swiftly from all the parts of the body into this vein, the motion being from the extremities to the larger channel, from the branches to the trunk, and that it moves thus, not the contrary way, through the veins, appears also, from the valves in them, which hinder any reflux towards the extremities.

'Tis therefore, sufficiently manifest, that the blood flows from the left ventricle of the heart, thro' the trunks of all the arteries, into their several branches, which distribute it through all the parts of the body, both internal and external; and that the veins, on the contrary, except the branches of the *Vena Portæ*, which are discharged into the liver, receive the blood from the former minute vessels, at their extremities, and carry it back into the larger branches, which convey it to the greater trunks, and from thence into the sinus, near the right ventricle



tricle of the heart, and some of it, at length, into the right auricle; for when the blood is collected, in the right sinus, it may be forced into the right auricle, when relaxed, by a muscle that encompasses that sinus, since there is no obstacle thereto; and 'tis likewise assisted by the pressure of the subsequent venal blood.

And since both the right and left auricle of the heart, are large, hollow muscles, furnished with a double row of strong fibres, which run in two contrary directions, to insert themselves into the tendons of the opposite sides, and supplied with many arteries and veins, one tendon being joined to the orifice of the vein, fixed to the left cavity of the heart, and the other growing to the circular orifice of the *Vena cava*, which is harder than the other. This muscle is contracted, forcibly drives the blood into the right ventricle of the heart, when relaxed; for, then the heart being empty, grows longer, the three *Valvula tricuspidales* draw back towards the sides, and the point of the heart, by the oblong, smooth, fleshy papillæ, which are oblong, and grow out of the sides of the right ventricle; which, being also drawn backwards, the whole passage is open, and ready to receive it. And this is not only apparent from the fabric of the part, but observations upon creatures opened alive, injections and blow-pipes confirm the same.

But, lest the right ventricle of the heart, thus filled, should, by the contraction of its fibres, press this blood, and the venous of its own strongly squeez'd substance back thereinto, from its wide-mouth'd veins, through the same passage, out of its own cavity; the resisting force, on every side, intimately mixes all the contents of the cavity: and these, being thereby pressed  
against

against the sides, elevate the *Valvula tricuspidales*, which are so fixed to the fleshy supporters, stretched out from the opposite side, that, falling close to the sides of the right ventricle, they are born off, and thrust towards the right auricle, till they join together, quite close up that passage, and perfectly hinder the reflux of the blood; those fleshy pillars not suffering them to be thrust farther backwards.

The same force presses the blood upwards, against the three semilunar valves, placed in the opening of the other orifice, which leads to the pulmonary artery dispersed through the lungs: the force of the blood presses these against the sides of the artery, and opens the passage into that vessel alone. The substance, figure and connection of these valves, shew them to be so formed, as to hinder the reflux of the blood out of the pulmonary artery, into the heart, by wholly stopping up the passage when joined together; and this they do the more exactly, the harder they are pressed back, as is evident, not only from the structure of the part, but also from observations made in bodies opened alive, arteriotomy, and injections.

Hence it appears, that all the venal blood, that is, the whole mass, passes from the sinus of the *Vena cava*, thro' the auricle, and right ventricle of the heart, into the pulmonary artery, in a continued, quick, and violent stream.

The blood, received out of the lungs, and, which is distributed through them by the pulmonary artery, is first admitted into the extremities of the pulmonary vein, called *Arteria venosa*, and, passing into four large vessels, which unite together, it is brought into the left venal sinus, by the force of whose musculous fabric, it is pressed into the left auricle, which is relaxed,



laxed, and by that means, prepared to receive it. This is much less than the right, but formed and placed after the same manner. From thence it is forced into the left ventricle, which is relaxed by the like means, and the two mitral valves opening, admit it into the left cavity, and hinder its reflux back into the pulmonary vein.

From hence it is forced into the aorta, or great artery, at whose orifice there are three semilunar valves, which also prevent a reflux, by exactly closing the same: and thus the blood circulates in grown persons; all that which moves through the lungs, into the sinus of the *Arteria Venosa*, the left auricle, and the left ventricle, being here continually propell'd into the aorta, with a violent and swift motion.

In this action, the following observations offer themselves. *First*, both sinus's, right and left, fill and grow tumid together; both auricles empty, and collapse together; and both are filled at the same time, by the contraction of the muscular venal sinus, adjoining thereto; at the very same instant, both ventricles of the heart are contracted, and press out the blood they contained, and the two large arteries are filled, and distended. As soon as the blood, by this contraction, is drove out, both ventricles are empty, and the heart grows longer and broader immediately; upon which, the muscular fibres, of both auricles and sinus's, contract, and press the blood, contained in those cavities, into the ventricles of the heart; and, in the mean time, the sinus's and auricles are filled, as before; and thus these motions are successively continued, as long as a man lives; but, when death approaches, the sinus's and auricles beat often,

often, for one contraction of the ventricles of the heart.

All the blood then, any where contained in a human body, even in every part of the substance of the heart it self, and its auricles, is forced into the right ventricle of the heart, and from thence, thro' the lungs, into the left, which propels it again into all the parts of the body; whence it again returns back to the heart. This doctrine was first found out and demonstrated by the immortal *Harvey*; and is confirmed by a variety of experiments made by the infusion, and transfusion of blood; and by the help of microscopes.

And thus the chyle, being constantly, and in small quantities, pressed through the thoracic duct, elevates the valve in the subclavian vein, which is constantly kept shut by the force and pressure of the blood; so that such a part of the chyle passes into the vein, whose acquired force of ascent, as before mention'd, is sufficient to overcome the pressure of the venal blood; which chyle passing along with the venal blood into the cava, is continued by the *Sinus venosus*, into the right auricle; and, at last, into the right ventricle of the heart.

By this moderate and constant supply, and mixture of the chyle, as well as by the concurrence of blood flowing hither from all parts, and drove with a rapid motion together; and also by the motion of lymph, plentifully brought back here, the blood and chyle are mixed together, prevented from coagulating, and preserved in a fluid state.

After this, they are further mixed, divided, and kept fluid, by being drove forcibly into the confined cavity of the auricle; and again,  
by



by the contraction of the same, which, with the pillars of the whole part, occasion various opposite motions, and concussions: the chyle is also more forcibly ground and divided, by the attrition of the blood moving about it; all which is much assisted and promoted by the parts of the blood recoiling, and being drove back by the substance of the heart, and its auricles; and meeting the other parts forced in from the sinus's, the intestine motion of the particles of the blood is increased, by the violent impulse out of the sinus into the auricles.

What effects are here likely to be produced by this violent motion, and mixture of the blood and chyle, may appear from the qualities of the blood, and the disposition of the chyle to receive its impressions; homogeneous and assimilating liquids being mixed therewith, and making part of its composition, in the action of mastication, concoction, chylication, and passage into the blood, which may render it more apt to mix, and to be alter'd by it. We are also, to consider the fabric and structure of the heart, and what alterations it may receive from the violent mixture, motion and concussions it undergoes there; but this is chiefly to be learnt by observations, and proper experiments.

The blood contain'd in the right ventricle of the heart, in an animal after fasting, hath no alkalious, but a sal-armoniac, or sea-salt tast; when mixed with acids, or alkalies, there appear no signs of effervescence, or fermentation; these only altering the colour thereof, and the degrees of its fluidity. If it be received into any vessel from the artery in the lungs, there appears no ebullition, or fermentation; but it smells strong, ungrateful, and sharp; and when cold,

cold, coagulates; one part of it adhering together in a solid mass, and, the other separating therefrom, remains fluid. If you cut off the mucro of a live heart, and turn the small end upwards, the blood is drove into the ventricles of the heart, upon the contraction of the auricles, but without any ebullition, or fermentation. This is more conspicuous a little before the death of the part; and the same phenomena appear in the blood contain'd in the left ventricle.

If a thermoscope be put into a live heart, it discovers no more heat there than in another part.

The chyle, in the thoracic duct, appears to have a sea-salt tast, or that which was most predominant in the food. If received in a vessel, and mixed with different salts, it seldom, or never ferments; and, by it self, it neither ferments, nor bubbles; neither is it perceived to do so in the thoracic duct, when mixed with the blood, whether in the subclavian vein, the auricles or ventricles of the heart; nay, if a ligature be applied to the axillary vein, before it reaches the cava, and another betwixt that and the valve, there is no fermentation in the intermediate space.

The lymph of the conglobate glands, separated from the arterial blood, mixed with the chyle, appears, by the same experiments, to be homogeneous, and of the same nature and disposition therewith. It, therefore, makes no ebullition, fermentation, or effervescence in the heart. In regard of which muscle, or the fluids therein contain'd, there are no considerable effects perceivable; no ebullition, fermentation, or effervescence: neither can the heat of the heart, as a new cause, work any alteration in



in the disposition or motion of the blood; or promote the expulsion thereof; nor is there any particular ferment in the heart.

The cause, then, which forces and drives the blood out of the heart into the arteries, and out of the veins into the heart, is not seated in the mass of blood, but in that which immediately contains it, the heart it self. To understand how the heart performs this action, we are carefully to consider the fabric and cohesion of its parts, as well as its force and motion.

But though there appears no evident ebullition, fermentation, or effervescence in the heart; and though the heat thereof does not contribute to its expulsive power; yet since there is such a brisk and violent motion, both of the blood and chyle, not only in the cavity of its auricles, but also in its ventricles, it must needs follow, that when the blood is closely confined and forced out of one part into another, and consequently the various particles thereof, which have different qualities, are violently rubbed together, they must necessarily subtilize and rarify one another; the more volatile parts grinding and breaking in pieces the grosser and less subtilized; the sharp and acuminated salts fretting and corroding the grosser phlegm; which will also dull the edges of those sharper particles; and since the new chyle flows along with the blood, that likewise must be further digested, attenuated and assimilated by these actions; though at first it may serve to mollify the same, and prevent too great an inflammation, which the frequent attritions of the more volatile, pungent parts might occasion. And, as the chyle consists, in a great measure, of parts separated from the blood, and consequently of qualities very similar thereto; these similar parts will more readily unite one with another, and render a fur-



ther assimilation more easy and expeditious; though this cannot be perfected, only promoted, in so small a time, and so short a passage.

Yet, that the blood, and consequently the chyle, must receive some, though no considerable alteration from this rapid, though not lasting motion, is evident, from the effects of universal violent motions of the body; for, when we move quick and often, the blood presently increases its heat; being briskly squeezed not only out of the ventricles of the heart, but likewise through all the muscles and canals of the body. But, to proceed to a more particular consideration of the fabric, force and action of the heart.



## C H A P. VI.

### *Of the Structure, Force and Action of the Heart.*

**T**HE heart being suspended in a large membrane, called pericardium, and fixed to the throat, sternum, back and diaphragm, either by its own parts, the ligaments it sends out, or the vessels distributed through it; and moisten'd, made slippery and fit for motion, with a soft lymph, from four large blood vessels, firmly fixed to the pericardium; and likewise, resting upon the diaphragm, and adhering in the cavity of the mediastinum, between the soft lungs, and free from the violent pressure of any thing adjacent,  
it



it is thus rendered more fit and apt to receive and expel the blood through all the parts of the body.

It hath two arteries, rising from the aorta, just above the semilunar valves of the left ventricle, which, taking different courses, unite into one canal, firmly surrounding the whole basis of the heart; from whence many small branches arise, and communicating with one another by several anastomoses, are distributed into a vast number of very small twigs, and so dispersed through every part of the heart; and, together with the veins, in like manner dispersed therein, make up almost its whole substance; external fat arising betwixt the branches of the vessels: these arteries are in their diastole, whilst all the others of the body are in their systole. The veins discharge the blood, partly into the coronaries, thence towards the right auricle, betwixt that and the right ventricle, and partly into the right auricle, and betwixt the right ventricle, by particular veins; all these are empty at the same time, that the rest of the veins of the body are full.

Besides these vessels, the heart is furnished with fibres, rising from the four orbicular tendons, that encompass the four orifices of the heart; and which are, for the most part, inserted into them again. First, a few small fibres rise from thence, and tend strait from the basis to the point, only on the outside of the right ventricle, which strengthen the fleshy fibres of that ventricle in contraction, and assist in the expulsion of the blood; others below the former, ascend obliquely to the right from the left side of the heart, in the right ventricle, and, terminating in that basis, run a spiral course; under these another series or order of fibres is placed, which rising from the right side of the heart, go to the left, and encompass and embrace both ventricles of the heart, pro-



ceeding up to the basis on the left side; they take a spiral course just opposite to that of the last mentioned: these fibres are common to both ventricles, and, in a like manner, encircle them both; they being opposite, strong and contracting together, press the whole heart equally on every side, and have all a like origine and insertion; they compress and squeeze both ventricles at once, and force them against the middle partition; by that means bringing the basis and cone nearer together. These fibres are assisted in this operation, by another series variously interwoven with, and twined round the two latter; which restrain and preserve them in their proper places.

The left ventricle hath two other series, or orders, of very strong fibres, proper to it self; the external of which, being under the others, rise spirally towards the right, about the whole cavity of the left ventricle; and, forming part of the septum, terminate in the basis of that ventricle; wholly surrounding its cavity; it hath also other peculiar fibres, like the last above mention'd: under these lie those of the last order, which, descending spirally and obliquely from the left basis towards the right, compose the internal parts of the ventricle; and, completing the middle partition, visibly afford abundance of fibres of different lengths, variously curved and twisted; besides these, the carnosus or fleshy pillars and cells, in the sides of the left ventricle, fitly dispose it to be very strongly and closely drawn together; not only by the common, but its own proper contraction: in the mean while, the rest of the fibres and small props, in the cavity of both ventricles, serve to keep the valves tight, when the heart is contracted, and to draw them back again, when dilated.

A great number of nervous fibres are also inserted into the auricles and the heart; they rise

from



from the nerves of the eighth pair, and, passing betwixt the aorta and the pulmonary artery, occasion and promote such muscular contractions of this part, as render its cavities firm, and apt to contract, without prejudice to the structure thereof, from its own proper and violent action. From whence it appears, that the left ventricle acts by its own proper orbicular, the right by the semi-orbicular contraction of its fibres; and that they are both assisted by one common external force; as is evident from dissection.

It is plain then, that the heart and its auricles are real muscles, and act by virtue of their muscular force; all the fibres being at once contracted, in their length, shorten the heart, make it broader, and closely compress its ventricles; they also dilate the tendinous orifices of the arteries, shut up those of the veins, by their valves, and violently press out the liquids contained into the arteries, through their dilated orifices; and this is called the systole, or contraction of the heart.

And that the blood is thus drove out of the heart, by this muscular contraction, appears by the starting of that fluid, out of the aorta and pulmonary artery, when cut near the heart, in a living creature. This farther appears, if the point of the heart be turned upwards, and cut across, by the pressure the finger receives when thrust into the wound so made; by the tumor, tension, hardness and paleness of the fibres; the contraction succeeding, and not preceeding, the hearts being filled, and the emptyness which attends its abbreviation.

If the nerves of the eight pair be tied up, or cut across in the neck, the motion of the heart grows languid, a palpitation ensues, with great anguish to the creature, and the motion in a little time, wholly ceases; which shews that the rise and



continuation of the heart's contraction depend thereon ; which, notwithstanding, wants, like any other muscle, the assistance of the blood from the coronaries, and a supply of the like fluid in its cavities.

The blood, being thus almost wholly driven out of the ventricles of the heart, by its contraction, and out of its vessels, its fibres grow flaccid, thin and long, the distance betwixt the basis and the mucro augments, the compression of the sides is lost, the valves, at the mouths of the veins, are drawn towards the apex, by the assistance of the little pillars joined to them, and the auricles contract and fill the ventricles, assisted by the venous sinusses ; and this is the diastole, or relaxation of the fibres of the heart.

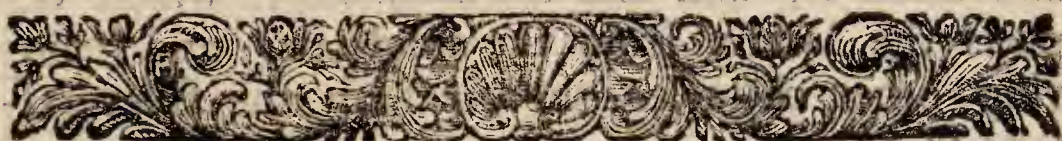
And that the ventricles of the heart are, at that time, filled with blood, appears evidently, by cutting any artery about the heart, and from the heart being cut transversely in a live creature, and held in an erect posture ; for it then receives, not throws out, blood ; also, by inspection, when an animal, open'd alive, is near dying ; likewise, by the flaccidity of the part, if the finger be thrust into the wound : it follows, that the circulation of the blood, and its expulsion out of the ventricles, proceed from the muscular contraction of the parts, and not from any rarification.

Farther, it appears, from the fabric of the ventricles of the heart, that the left ventricle is to make a stronger contraction, and expel the blood more forcibly, than the right ; which only forces the blood into the soft and tender lungs ; a greater force being likely to prove prejudicial to them, and strain those delicate vessels : whereas, the left is to distribute the blood thro' all the body.

Lastly,



Lastly, it is hence evident, that a small quantity of chyle, being mixed with a much larger proportion of venal blood, and attenuated, and shook therewith, by the force of the heart, is all pressed forwards together, into the pulmonary artery.



## C H A P. VII.

*Of the Fabric, Force and Action of the Lungs.*

**I**N considering the structure of the lungs, we are to take notice, both of the vessels which contain air, and those that contain blood; in order to see what changes the blood and the chyle undergo herein.

Its vessels, which contain air, have a power to receive and expel it, when 'tis either to be drawn in or forced out, through the nostrils or mouth, by means of a chink or aperture in the glottis, which always remains spontaneously open and free for the passage thereof; being formed of the two cartilages, called *Arytænoides*, and covered with the epiglottis, which lies thereon, and keeps it close, while in the act deglutition; but 'tis opened, at pleasure, to give passage to air, by a strong ligament which lifts it forwards: the said chink is shut and closed, the epiglottis being depress'd, and the *arytænoides* contracted, by means of the



muscles *Arytanoideus rectus*, which is single, and the two *Arytanoidei obliqui*, which cross each other, and lie upon the former; as also, by the *Thyroarytanoidei* and *Hyothyroidei*, which contract the chink, and, by compressing the upper part of the larynx, hinder the admission of any substance besides air; but when it is dilated by the muscles *Cricoarytanoidei*, which are placed both behind and aside it, and the *Sternothyroidei*, which depress the larynx from the epiglottis, and removing other obstacles, the air hath the freer passage in or out.

Here commences the *Aspera arteria*, consisting of a cartilaginous substance, formed in orbicular segments, the back part being wanting; this interval is supplied by a strong membrane, fixed to each end of the cartilages, which are also connected together by a strong musculous cord: this part, thus formed, affords the air a free passage along the smooth and slippery sides of the membrane; the pipe being always open for that purpose; but besides, this expanding orbicularly, it gives way to the gullet, in deglutition, to the bending of the neck, and easily admits of the lengthening and shortening of the whole, as occasion requires; the whole membrane on the back part, which supplies the deficiency of cartilages, is thick set with glands, that prepare an unctuous humor, and discharge it into the cavity of the trachea through proper vessels, perforating the strong coat on the inside thereof; and this serves to anoint or lubricate the whole tube.

The trachea, descended about as low as the fourth vertebra of the thorax, is divided into two branches, which are still composed of circular cartilages, joined, as the others, with a glandulous membrane on the back sides thereof; and then



then it is presently divided into numberless branches on both sides, of a like structure with that of the *Aspera arteria*; only the cartilaginous segments are nearer to orbicular, and oleaginous furrows are there seated on the inside amongst the strong fibres. These branches lie upon one another at acute angles, growing gradually narrower and finer; and, losing their cartilaginous substance towards the extremities, they become membranous; and the force of the air extending their pliable membranes, they degenerate into small, limber bags, spreading about all the extreme points of every branch, whence small bladders arise; out of these spring lobuli, at length five lobes, three on the right, and two on the left side of the lungs; and thus all the air-vessels of the lungs are continued from one another, and become complete.

If air, therefore, which is fluid, weighty and elastic, admitted by the glottis into the trachea and bronchia, distends these tubes, with their several branches and vesicles, the orbicular capacity and length hereof, and the distance or spaces betwixt the squamous segments, branches and bladders will be increased, and the points of their contract diminished; the branches will rise into greater angles, the lobes grow turgid, and the little bladders form a flat complex figure, distended into a round one.

Here, the pulmonary artery being curved, soon after its rise out of the heart, is divided into innumerable branches, and distributed along with the ramifications of the *Aspera arteria*; the extremities of its small branches forming a sort of network, about the surface of its *Vesicula*, and, in like manner, possessing the intermediate spaces betwixt them, called cavernous; where it inoscu-  
lates



lates with the veins, by an infinite number of arterious anastomoses.

These veins, having a like curvature, distribution, course, texture and situation, receive and carry back the blood brought thither by the arteries, and having here undergone the usual changes and alteration by the action of that part, it is discharged into the great pulmonary veins; and from thence into the four large vessels, which, united, convey it into the venous, pulmonary sinus; from whence it is received into the left auricle, and thence into the left ventricle.

From this fabric and structure of the lungs, the power of the air upon them, and the swift passage of the blood and chyle through their substance, we may understand what effects are produced on the chylous blood by respiration.

*First*, then, that humor is forcibly drove and pressed together, by the contractive force of the right ventricle of the adjacent heart, into a crooked, conical, flexible and elastic tube; which resisting its pressure, it is there compressed, condensed, changed in the contact and figure of its particles, dissolved, ground together, and kept fluid.

*Secondly*, by the motion of the *Vesiculæ* in the lungs, when distended by inspiration, which are gradually and successively pressed in fewer points; by the change of the cavernous spaces, at the same time successively enlarged; by the motion of the *Vesiculæ*, and those spaces, which are successively made less upon expiration; and by the spring of air, quietly retained after inspiration or expiration, which is constantly increased by heat: I say, by all these means, neither the arteries, veins, blood, nor any other humors in any of the pulmonary vessels, are successively, for two moments, equally and alike pressed; but reci-



reciprocally squeezed, propelled, shook together, press'd back, rubbed one against another, ground, divided, lessen'd, broke fine, and thereby fitted to pass through the delicate vessels of the lungs.

*Thirdly*, the chyle, therefore, made ready in the mouth, digested in the stomach, elaborated in the guts, strained in the lacteals, diluted by the mesenteric glands, further thin'd and mixed in the thoracic duct, admitted to the blood in the subclavian vein, and more powerfully blended therewith in the auricle and right ventricle of the heart, where 'tis still more dissolved, ground and attenuated; and being also, in the conical and cylindrical vessels of the pulmonary artery, both from the blood behind and the lateral repercussion of the vessels, violently pressed and shook together, 'tis fitly prepared and adapted to constitute and supply the deficiency of the solid, as well as fluid parts of the body: again, the chyle is still farther digested, and more intimately mixed in the pulmonary veins; and here also, 'tis, perhaps, again attenuated and diluted by the lymph, as was said of the blood, and still more subtilized and rarified by a continuance of the same motion and intestine attrition; and thus, by degrees, it is reduced to a form and disposition proper to afford convenient nutriment to the parts: and, by this intestine motion and continual attrition of the parts of the blood, the fluidity of the rest is not only preserved, but its heat continued, and all the humors and particles of the body preserved perfect, both the newly receiv'd and the old perfectly mix'd; which mixture of the air, blood and chyle may greatly contribute to promote that property of good blood, a red color; or to cause an assimilation of the parts that are most disposed to put on such a form, as produces that quality.



Whether the pondrous, elastic particles of the air, being here mixed with the blood, cause the vital, elastic oscillation, according to *Borelli*, is a question; 'tis impossible it should be in the arteries, considering their situation, and cannot be proved in the veins; and here, such a communication seems rather hinder'd and obstructed, by the air distending the *Vesiculae* of the lungs, and compressing the veins in inspiration; by the pressure of the thorax, contracting them in expiration; by the particular change of a vein into an artery; by the difficult passage that air finds thro' such small pores, as admit water, oil and spirits; by the slimy humor there separated, which moistens and lubricates the membrane that covers the inside of the trachea; and lastly, by the ill effect of air admitted into the blood.

Others think the blood is here exposed to the air, to cool and carry off its fuliginous parts, or supply it with spirits; but this is contrary to ocular demonstration, anatomy, and experiments made by the thermometer.

Some, as *Sylvius* and many of the chymists, think, that the blood, being violently fermented in the right ventricle of the heart, and, growing very hot by a strong ebullition, is again condensed; and the burning heat thereof damp'd, extinguished and cooled, by the force of cold nitrous air in the lungs. The great *Dr. Lower* supposes, that, by the mixture of a subtile nitrous substance of the air, the blood acquires a purple color; it is very evident indeed, that the chyle, in the right ventricle of the heart, is rather confusedly than perfectly mixed; that, in the left ventricle thereof, it is more intimately united, which is owing to the strong force of the lungs; since, if that force be weaken'd, the mixture is always less perfect.

When



When the blood with the chyle, thus changed, flow, out of the narrow arteries, into the larger veins, 'tis pressed forwards by contrary motions; being less compressed, its spring occasions it to rarify the more, and so it is forced into the left ventricle, more frothy, florid and red, which may, in some measure, also depend on its being exposed to the nitrous property of the air.

In the left auricle of the heart, though much less here than in the right, it is again more perfectly mixed, by a continued and successive force and intestine motion; and thus kept fluid, and a concretion, separation and division of the parts prevented; from whence, the blood, having before undergone a considerable alteration in the lungs, preserves its fluidity, and is less subject to coagulate: and hence it appears, why the left auricle is less, and its structure more simple, than the right.

The blood and chyle, being thus brought to the left ventricle of the heart, is quickly, by a strong and violent contraction thereof, forced into the great artery, which, by that means, propels forwards what was discharged in the former systole; thereby promoting the progressive motion and protrusion of the whole.

The lungs, in a sound body, therefore, seem to be of greater force and efficacy, than any other viscera, in perfectly mixing and attenuating the chyle and blood; since, not the least drop of the arterial fluid is distributed to any part of the body, before it is first brought to, and most exactly passes through, the substance of the lungs; in the same time that all the vital fluids are distributed to the several parts, and finish one circuit through the whole, they pass entirely through the lungs; hence the whole mass of fluids is forced through this single part, whilst



whilst only a portion of them flows through the other viscera.

The learned *Boerhaave* supposes the proper nutriment of the whole body to be here prepared, from the chyle's being all brought hither; from a consideration of the nature of the blood and chyle; the structure and action of the part it self; the force of the heart; the pressure, fluidity and spring of the air upon the peculiar air-vessels in the lungs, and, by means thereof, upon the blood-vessels also: but 'tis a question, whether so tender and delicate a part, as the lungs, can exert so forcible an action, as is here supposed; and whether the soft and mild chyle be not, therefore, destin'd to it, without undergoing any other alterations, than those already mention'd.

The same author also, supposes this part to be the elaboratory of the blood; but though the chyle be here altered and attenuated, perfectly mixed and disposed to assimilate therewith, yet it requires still farther alterations to give it the form of blood; as will appear hereafter, from the action of several other parts of the body.

'Tis true, indeed, its here greatly attenuated, comminuted and rarified, by attrition, a further digestion, and by being perfectly mix'd with the blood; by this means, also, it becomes more fluid and apt to circulate through the minute canals of the body, and is, consequently, made more fit for secretion, and all the actions of life and health; but no more can hence be fairly concluded.

Again, though our learned author allows the air to press upon the sanguiferous vessels, and, by that means, to compress them; yet he is not willing to grant, that the nitrous parts of the air pass into the vessels, and impregnate the blood with any thing it contains: but, if we consider the  
strange



strange subtlety of nitrous particles, and the wonderful porosity of fluid, and even solid substances, it will seem very probable, that the air, which is actually well furnished with fine, nitrous parts, by passing continually backwards and forwards in respiration, may communicate them to the mass of blood: we see, that water, wood, and even stones themselves, easily admit such penetrating parts within their pores; nay, the hardest of metals, and the most close and compact bodies, do the same; 'tis fact, that the external pores of the skin, closed and constricted by cold, do not resist, but readily receive them; which thereby affect the minutest fibres, with the sensation of cold; and, when too plentifully infused into the mass of blood, they congele, condense and thicken, not only the red, but serous part and the chyle; as easily, surely, may they affect and impregnate the mass of fluids, when sucked, or impelled into the fine *Vesiculæ* of the lungs, whose pores expand by the spring of the air; especially, when rarified by warmth and heat.

From all that hath been said, of the structure of the lungs, and the manner of the blood's passing through the vessels thereof, it appears, that they not only serve to digest, dilute, attenuate and mix the blood and chyle together, by variously determining the motion of their parts, and shaking and grinding them one against another, by progressive protrusions and lateral repercussions; but also, that the *Vesiculæ*, forcing against the extremities of the arteries, squeeze it, when forced out of the right ventricle; and pressing, also, against the veins, promote or quicken its motion towards the left sinus; and, likewise, assist that in throwing it into the auricles; and, by these means, circulation is promoted.

And,



And, as this constant motion serves to attenuate and prepare the blood and chyle, to pass through the finest capillary vessels, that it may be fitter for the actions of life and health; so, doubtless, the air, in the *Vesiculæ* of the lungs, impregnates the blood with nitrous qualities, of great use in the animal economy; for though, when admitted in too great quantities, they render it less active, by retarding its motion, and so depress and chill the more spirituous parts of the blood; yet, when gradually instilled and imbibed into the mass of fluids, in a small proportion, by means of the warm lungs, the action thereof perfectly mixes all their parts together, and puts them in motion; whereby the nitre is rarified and united to the grosser, lixivate salts of the blood, which it serves to dilute and attenuate.

What other uses, the nitrous particles of the air may have, will appear from the effects of nitrous salts, taken into the body, which thus assist the lixivate salts to pass off by urine; and likewise, prepare it to separate from the mass in the glands of the kidneys.

That this nitre may be farther serviceable, in dissolving phlegm, as a menstruum, or otherwise cleansing the humors of superfluous, vitious, and depraved saline bodies, appears from the internal effects of nitre; and the breathing of air, of different qualities, in different climates and seasons of the year.

But, besides this use of the lungs, in respect of the mass of blood and chyle, and by consequence of the whole body; they likewise serve as a necessary and mechanical engine for the service of the soul; by helping us to form articulate sounds, to express and communicate the intentions and conceptions of the mind from one to another.

And,



And, as the air breathed in is of use to form articulate sounds, and to express the thoughts of the mind, by means of the voice, so the lungs, being constantly in motion, stand in need of a natural moisture to lubricate the internal membrane of the trachea, which is never at rest: now, the air, divested of its nitrous parts, which were before lodged in its interstices, may readily imbibe the superfluous moisture of the internal membrane, and discharge it by expiration, which would otherwise block up the *Vesiculæ* of the lungs, and hinder the ingress or effects of air, that is necessary for the above-mention'd uses.

And, that the nitre of the air, thus received into the blood, helps to attenuate the grosser and lixivate salts of that mass, and to dispose them to separate, and be discharged by urine, is not only evident from daily observations, and experiments of the effects of nitre physically used, and breathed in different places; but that, it also, helps to correct and attenuate other vitious and depraved humors, is manifest from the alterations made in several persons, who, being affected with distemper'd humors of various kinds, find great benefit by moving into an air, where the nitre is sharper and more attenuating.

As the sub-saline, pancreatic juice, therefore, serves to attenuate and dilute the chyle; so the nitrous particles of the air serve to attenuate and dilute the blood and serum, or finer lymph.



## C H A P. VIII.

*Concerning the Force and Action of the Arteries, on the Fluids they contain; with the Nature of the Blood, its Parts, and the Phenomena observed therein.*

**T**HAT we may understand what happens to the blood and chyle, when pressed into the aorta, and its utmost ramifications, we must consider the laws of hydrostatics, whereby the humors are govern'd, and moved with a certain velocity through the canals already described.

These laws are elsewhere deliver'd, and belong, in common, to all sorts of fluids, moved in what vessels soever.

The degrees of velocity are here measured by the causes and effects observable to sense, or found by just reasoning: but as to the canals, and the fluids moving therein, their nature must be learned by sense, the use of microscopes, injections, and reason; or else by this rule, The insensible parts of a human body are as the sensible.

An artery, which hath already been described, is distended by the force of the arterial blood, violently pressed thro' it; but when that force ceases, it spontaneously contracts to its former dimensions; for if the finger be thrust thereon, it presses



ses close about it, but when that is taken away, it contracts of it self: in a live creature it appears full, but in a dead body, even though it retains all its blood, tis small and almost empty. It likewise resists, when distended, by inflation, and forcibly drives out the air blown thereinto; when contracted to its least diameter, it is at rest, its contractive power, therefore, depends upon the nature of its fibres, with a fullness of the vessels, which form its membranes.

Nor, is there any sensible part in the whole body, without a small artery, as appears from wounds, the use of microscopes and injections; and these are continued even to the very middle of the bones, where we find both membranes, vessels, and fluids. But all these vessels are ramifications of the aorta.

When the blood is drove into the aorta, it is, in some measure, resisted, by that already contained in the arteries, by the conical figure thereof, by their turning and winding, their elasticity, and the weight of surrounding bodies, whether they lie above, or press laterally, and lastly, by the narrowness, and smallness of the extremities of the vessels; so that this fluid passes through the vessels, by the meer excess of the force, given by the heart, above the sum of all their resistances: And therefore, it is drove through the lungs with less force, as meeting there with less resistance. This shews a vast force in the heart, whether we regard the greatness of the several impediments, by how much it exceeds them, or the quantity of fluids to be moved.

Since then, the whole mass of blood is drove so forcibly, and is so strongly resisted in its passage through a full, conical, flexible, and greatly elastic tube, it follows, that the diastole of an artery, which happens at the same time the heart



contracts, is an unnatural violent motion; whilst that of the heart is natural; and that this happens every where, at the same time in a sound body, appears from the fulness of the vessels; but it is chiefly perceived, where the artery is large, bare, and lies upon some hard part.

And, as long as the natural, contractive and elastic force of the artery, strongly resists this diastole, and the pressure of the parts adjacent assist that resistance, it must needs follow, that the artery thus enabled, forcibly compresses the blood, which would otherwise be at rest, by its contractive power; the blood thereupon, must flow in a continued, but starting stream: this motion, thus occasioned, is called the systole of the artery; which is performed at the same time, with the diastole of the heart; being natural to the artery, and not forced, but assisted by the falling back of the valves of the aorta, and the emptiness, and flaccidity of the coronary arteries. These two motions make what is called a pulse, in which, the strength, greatness, fulness, number, equality, and their contraries are observed by physicians; though these are scarce the same, in two different healthy persons.

The blood being drove out of the heart, is forced against the aorta, in an oblique motion, at a very acute angle, and pressing against the same, is almost wholly forced into the curvature thereof; when by the figure, and elasticity of this part, and, the resistance of the mass it self, it is impelled back again; which every moment occasions a different motion and tendency to all the particles of the blood; as also a fresh rotation, a perpetual attrition, an attenuation, density, smoothness, and similitude of the parts of the blood: this motion, therefore, promotes the fluidity of the whole mass,



mass, increases its heat and colour, and by dividing and rarifying its parts, accomodates and makes them fitter to circulate through the minute vessels of the body: by this force also, the blood is pressed into all the lateral ramifications, and forced through the capillaries, without danger of obstructions; and all this is farther promoted by the anastomoses, in the small arteries, where opposite motions, contrary incurfions, mixtures and separations happen almost every moment.

If the blood, how good soever, be not thus continually kept in motion, and its parts ground and rubbed one against another, it soon congeals, and grows of a more solid consistence; but whilst thus agitated, and variously impelled, it remains fit for circulation, the preservation of life, and the continuance of a healthful state. But since the arteries gradually increase, both in number and capacity, are in some places narrower, and in others broader, and have, also, every where something continually separated therefrom, which never returns to them again: and since also, in the minute vessels, there is, perhaps, the greatest resistance, not only of the arteries, but the circumambient parts; the motion of the blood, must be proportionably very strong near the heart, but very weak near the extreme parts.

But, the nature of the blood it self, is in a great measure, the cause, both of its different course and velocity, for, it consists of abundance of parts, as appears from the conversion of the aliment thereinto, the several substances it spontaneously affords by rest, when extravasated, and by a chymical analysis.

There are, therefore, in the blood, some parts already in motion, which have a great disposition thereto, being solid, smooth and round;  
G 3
others



others are sluggish and unapt to move by a little force, and are, therefore, porous, angular, rough and viscid; whence it is evident, from hydraulic, hydrostatic and mechanic laws, that the parts of the blood, though drove with the same contractive force of the heart, will not move with the same velocity, continuance and direction: the first mentioned will tend from the heart in a strait line, with a swift and constant velocity; but the latter will be apt to move in the vessels more slowly, obliquely, or backwards.

Why the blood, in the veins of a dead body, continues for a long time mixed and fluid, without any coagulation, yet soon coagulates in the heart and arteries, appears, in that the most liquid juices continually flow into the veins, where nothing is separated from them; whereas the most fluid parts of the arterial blood are continually drain'd off, and nothing of that kind returned back to supply it.

The blood, as it circulates in a living body, seems to be, every part of it equally red, but viewed through a microscope, 'tis full of small, globular parts of a red color, swimming in an almost transparent serum. These globules, being composed of six smaller joined together, refract the beams of light, so as to exhibit a red color; but, being separated and divided, they make a quite different refraction of the light, and appear like the transparent serum, of which there are several different colors. From whence we see, that this difference of color depends upon a different refraction of the rays of light, occasioned by the different bulk, figure and contexture of the parts of matter that compose the blood.

From the particulars hitherto delivered, we learn what the blood is composed of, with its  
quan-



quantity, figure of its parts, and various colors: but it is hard to know how far these parts of the blood may be subdivided into lesser globules, or ranged in a different contexture: it is certain, however, that the red and grosser parts are the effects of its forms; and what is the office of the gross and more ferous parts; and why they are so necessary in the blood of a sound and healthful person.

There is no fluid in the body that more claims the regard of a physician, than the blood; and all the helps we can make use of are too little, to manifest its nature and properties sufficiently. It is the spring and origin of all the other humors in the body, and, when vitiated, the principal and primary instrument of numberless diseases. This fluid, which we see is red, when warm, of an urinous and sharp scent, thinish but somewhat viscid and glutinous, will coagulate with acids, and liquify with alkali's; when received from the body into a vessel, it all presently congeals into a continuous mass as it cools, which, of its own accord, sends out a thin watry juice, like sweat, through little imperceptible pores; but more plentifully on the lower, than on the upper side; and this transudation is greatly promoted by small punctures, made in the coagulum; which shews some parts in the composition to be elastic: if this coagulum be carefully diluted with water, though it seem not to consist of two different substances, yet innumerable red particles will hereupon gradually subside, and leave a thick, firm, pellucid, sily matter; which, being gently dried, appears to be composed of membranes and fibres; and, by drying it still farther, it becomes like horn. In like manner, the serum, which also appears homogeneous, is, by a gentle heat of the



fire, reduced to a thick, whitish matter, like the white of a boil'd egg; which gradually yields, out of its substance, a salt, watry juice, greatly resembling urine. Blood, therefore, in its natural state, consists of four different substances; namely, thick and fibrous, thin and fibrous, red or purple, and lastly, watry, or urinous parts. This is easily made manifest, by pouring hot blood into luke-warm water, which growing cool, the more gross fibres of the blood, thickned by the the bare cold, may be drawn out lik flax; whilst the red, the more fine, fibrous, and aqueo - saline parts, remain mix'd with the water: but this, being passed through paper, will leave the red part alone behind in the filtre; and, if the remaining fluid be gently boil'd, the finer fibres of the blood therein contain'd, will, by means of that heat, concrete together; whilst the urinous part will obstinately continue inseparably mix'd with the water. And, by this means, the proportion of these four parts of the blood, though not geometrically, may yet physically be discover'd; which is sufficient for any medicinal purpose.

This doctrine seems also confirm'd by microscopical observation; for, *first*, there appears in the blood, when viewed through a good glass, long, cylindrical, pellucid parts, or shavings, resembling hay, mutually intersected, entangled, and greatly confounded with each other. *Secondly*, red, spherical, or spheroidical particles, as above-mention'd, interspersed among the former; but these are so small, that *Leeuwenhoek* says, five and twenty thousand of them do not equal a grain of common sand. *Thirdly*, watry parts, wherein no determin'd figure is, in a natural state, observable; but, after a little evaporation, they appear to be globules, swimming in a serous fluid.

Again,



Again, the blood of a healthy man, gently distill'd, affords a large quantity of phlegm, impregnated with some alkaline salts; for it turns a tincture of mallow-flowers green: what afterwards remains in the retort, being exposed to a reverberatory fire, yields a brownish spirit, greatly mixed with a volatile, alkaline salt; for this also turns a tincture of mallow-flowers green; besides, it presently ferments with acids, and precipitates a solution of *Saccharum Saturni*. A volatile, alkalious salt next fixes, like crystals, to the upper part of the receiver. *Thirdly*, a thick, blackish, fetid oil comes over, full of volatile salt, as appears by the preceding experiments; this liquor, moreover, is inflammable. *Lastly*, there is left in the retort a dry matter, which affords, by a lixivium made in warm water, some fix'd salt, like the common sort, that falls to the bottom of the vessel: and, after this operation, a fine *Terra damnata*, only, remains. Notwithstanding the difficulty in making the experiment exactly, we may safely conclude, that every part of the blood consists of a large quantity of phlegm, a considerable deal of volatile salt and sulphur, and but little fixt salt and elementary earth.

Lastly, if warm blood be included in a receiver exhausted of air, by an air-pump, it suddenly emits numberless bubbles, which show it to include air in its interstices.

The velocity of the blood, in its circular motion, might be easily determin'd, if its quantity and the capacity of the left ventricle of the heart could be ascertain'd in every subject: but, as these can only be known by approximation, so the blood's velocity is only to be estimated by approximation. Suppose then, an ounce of blood be thrown into the aorta, from the left ventricle  
of

of the heart, at every systole, then, in an hour, four thousand ounces, (for so many times the heart beats in that space, when a man is in health) that is two hundred and fifty pound weight, will be thrown therein; allowing, therefore, the whole circulating mass of blood to be eighteen pounds, it follows, that all the blood in the body passes, near fourteen times every hour, thorough the left ventricle of the heart.

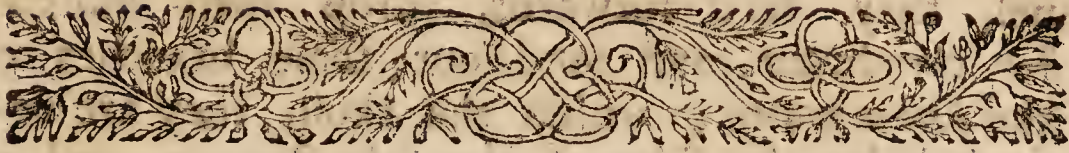
From hence it will easily appear, what ought to be thought of the *Galenical* doctrine, or the chymical way of explaining the nature of the blood. It will, therefore, be much better, to suppose the differences of the blood in different persons, and the temperaments depending thereon, to proceed from the different forms of the parts of matter which compose it, and the various contexture thereof, affording water, salt, oil and earth.

And, indeed, it appears, *a posteriori*, that the motion and circulation of the blood is alone sufficient to assimilate it, and preserve its mixture, fluidity, heat and color: for, as this increases or decreases, is present or absent, so all these properties are continued or destroyed.

We shall, therefore, in the next place, see what happens to the blood and chyle, when forced by the contraction of the heart and arteries, into the capillaries, the glands, muscles, excretory vessels and viscera.







## C H A P. IX.

*Of the Arteries distributed to the Cerebrum and Cerebellum, with their Nature and Use. Of the Cortical Part of the Brain, and the different Structure of the Glands. Of the Medullary Part of the Brain. Of the Animal Spirits; the Venous Fluid; the Origin of the Nerves; and the Circulation of the Blood.*

THE first thing, we shall here consider, is, the origin and distribution of the carotid artery. The aorta, rising from the left ventricle of the heart, and ascending a little upwards, presently makes an arched bending, and sends out the subclavian on its right side; to this the right carotid, growing for some space, shoots out, as if it rose, therefrom; but the left subclavian rises single from the arch: both of them being placed or situated deep under, and defended by the *Aspera Arteria*, without windings or being compressed by any part, and almost, without sending forth the least branch, proceed in a direct course to the skull; where, being almost arriv'd, they send forth the external carotid branch;



branch; and, being defended by a bony channel, they tend forwards, drop their muscular membrane, and send out some branches to the *Dura mater*; within the skull, they are defended by the sides of the *Sella Turcica*, and a branch of the *Dura mater*, and soon spread on the outside of the *Pia mater* and nerves; by the help of the *Pia mater*, they are inserted into the brain; where they are presently divided into branches, that run forwards, sidewise and backwards, through the whole substance thereof.

But the vertebral arteries, rising upwards from the superior part of the subclavians, being presently dispersed betwixt the lateral perforation of the seven *Vertebræ* of the neck, which receive and defend them; and, being continued right on, and sheathed with a membranous coat, they divide into several branches; where they presently rise out of the perforations of the *Vertebræ*, under the superior processes, bending backwards to the hind part of the first *Vertebræ*, and, growing broader there, leave their thicker membrane; and, being united with one another, and joined to the carotids, they enter through the great foramen of the occiput, and presently divide into several branches, after a wonderful manner.

Thus, four arteries, from opposite parts, join together in mutual canals, and make up an orbicular stem, when they presently send out branches, which, in like manner, meeting with others, form the like small circular stems; and, after this manner, being spread over the superficies of the *Pia mater*, they are subdivided till they disappear, and are almost lost; so that this whole membrane is chiefly composed of these vessels, interwoven together.

And by this mechanical contrivance, all the blood, sent from the heart to the brain, is conveyed to  
this



this fine membrane, belonging both to the *Cerebrum* and *Cerebellum*, and is from thence dispersed to the substance of both; for, the rest of the blood, which is brought within side the cranium, enters by two arteries, rising from the external carotid, through a single perforation; and, entering the skull, and being distributed in the *Dura mater*, are only appropriated to the thicker integuments of the *Cerebrum* and *Cerebellum*; as the famous *Ravius* hath demonstrated, by curiously injecting these vessels with wax.

From hence we plainly see, that the blood, by its own peculiar disposition, which it still perfectly retains, being drove to the lower superficies of the basis of the skull, and, having there left the saliva, and the mucus, or having spent the more viscid portion on the *Vertebrae*, becomes purer; being also abated in its motion, by the curvature of the artery, and cleansed of the grosser parts, in the cavities formed of the *Dura mater*, near the sides of the *Sella Turcica*, it is drove, by contrary tendencies in the vessels just now describ'd, against the blood brought thither by the other arteries; from whence, the nature of it being preserved, or a more pure one acquired, its force is likewise hinder'd, from pressing too much upon the tender pulp of the brain: by this means, also, a perfect mixture of the blood brought hither is caused, and, consequently, all its parts are render'd similar and homogeneous; the blood is, likewise, by this motion, attenuated, rubbed together and ground finer, by a mutual, intestine attrition, which preserves its fluidity and aptitude for secretion, or the separation of its more spirituous parts, and is, consequently, less apt to coagulate; and, as there is here a less vibration in the arteries, so their action upon the blood is lessen'd thereby. Lastly, the deficiency, which  
might



might arise from the unfitness of the vessels, either small or great, to furnish every part with liquors, is here supplied; there being a free communication betwixt every part, and a mutual discharge out of one vessel into another.

These arteries, thus regularly and strongly interwoven one with another, in the thin membrane of the brain, as a basis that is surprizingly fine, and like a cobweb, they send down, from every point thereof, branches almost perpendicularly, to be continued by anastomoses, as it were, into a membrane, that, by its insinuation, forms winding furrows, which divide the substance of the cerebrum and cerebellum from their external surface, almost quite down to the medullary part. These tracts, or divisions, being wound about, like the intestines, are resolvable into other convolutions like the former. The greatest part of the substance, which lies betwixt these, and which remains in the cerebrum and cerebellum, injected with wax, then steep'd in water, and separated clear from every part which is not injected, appears to be a parcel of minute vessels, like wool, being soft, moist, and easily dissolvable; and, if only suspended in water, fall in a soft, pulpy substance.

The external, soft, moist substance, of an ash-color, is called the cortex, or cortical part of the cerebrum and cerebellum; this exactly covers the whole origin of that other internal substance, which, being very white, more solid and dry, than the other, is term'd the medullary part of the cerebrum and cerebellum: this latter manifestly appears to rise from the other every way, as in the appendixes, the ventricles, the *Medulla oblongata*, and its *crura*, or expansions. But, in the internal part of the spinal marrow, the inner substance is like the cortical part of the brain; being



being every where full of arteries, which cortical part, is inclosed in the medullary one; the order of these two substances being here inverted.

In the cerebellum, the cortical part is so clear, that you may easily discern how the medullary rises therefrom; being easily seen and distinguished in its due proportion and fabric.

Since then, by every pulsation of the heart, a very great quantity of blood (according to *Malpighi*, a third of the whole) is carried, with a great and direct force, into the cortical part of the brain; that blood will be agitated by the systole and diastole, though they be small. Besides these, there must needs be small veins, distributed in every part, to return the arterial blood, though they are not visible, by reason of the smallness of their bulk and membrane; there must, also, be some secretory vessels at the extremities of these arteries, which, rising from every part, may terminate in emissary vessels, to discharge what is separated, though these, likewise, are so small, that they cannot be seen.

This minuteness of these vessels hath been the cause, that reason, though too weak, has attempted to supply the defect of inspection, by proposing various opinions; but that of *Malpighi* was most universally received, which supposed this part altogether glandulous; till the contrary was asserted by the famous *Ruysch*, who excels all the world in discovering, explaining, and preserving the most minute arterial branches of the human body. We must, therefore, before we proceed farther, take notice of the structure of the glands, according to the famous *Sylvius*, *Steno*, *Wharton*, *Graaf*, *Malpighi*, *Bellini*, *Borelli*, *Peyer*, *Ruysch* and *Nucke*, who have made great discoveries herein.

The



The glands are of several kinds, in respect of their structure and use. Some of them are simple, others compound; or a congeries of simple ones, enclosed in a common membrane. The simple glands separate and discharge a proper humor, which, carried through their lymphatic ducts, is mix'd with the chyle, or venous blood; or else transpires through the pores of the skin, or the coats of the looser membranes, found in all parts of the body: but the compound glands discharge the fluids separated in them, and prepared in every part, by a small tube inserted into a larger duct; and this common canal opens, at last, into the great cavities of the mouth, gullet and intestins; or else discharge themselves out of the body, either as excrements, or for some particular use: the first kind are called conglobate, and the latter conglomerate glands.

The simple glands are composed of an external membrane, which is very thin, and an internal one, which adheres fast to it. The first, composed of circular, elastic fibres, that enclose it on every side, contract, compress it, and squeeze out the contents; chiefly consisting of a contexture of the small vessels, which enter into, and pass out of it: the latter being thicker, more close, and consisting of fibres differently distributed, and vessels very intricately interwoven, serves almost for the same use. They are furnished with arteries, whose branches are supported by those membranes, in a firm and regular order; and so accurately distributed and conveyed to every minute particle of the gland, that if wax or quicksilver be injected into the small arteries, by increasing them, and compressing other vessels, it proves the notion, that the whole fabric is arterious, or composed of the ramifications of arteries, to be false. They are, also, furnished with veins, distributed  
in



In a like manner with the arteries; they have likewise more large twigs of nerves than any other part of the body, of the same magnitude, which are also distributed through the whole substance of the gland; besides these, they have proper lymphatic vessels, which convey the lymph separated from the arterial vessels, into convenient parts, and where necessity requires it.

And here we must farther observe, that these arteries are tubes, of a conical figure, curved, elastic, branched out, and winding about the substance of the glands, cylindrical at the extremities, no more divided, and now changed into veins; but, before they suffer this change, the small arteries, which are innumerable, communicate with one another at right angles, by numberless anastomoses in various positions and angles; so that the extremities of these vessels are distributed, after a very different manner, in the several glands. The arterial blood is, therefore, pressed into the glands with a great force, and suffers a strong resistance, compression and re-action of the parts, against which 'tis forced, an oblique pressure and mutual percussion of its parts, and a constant change of the points of contact; 'tis also every where forced against the smallest points of the vessels, and the opposite parts are every moment variously pressed and thrown against each other; by this means, there is both a propulsion and regress of the blood into the branches, which is still more attenuated by attrition, and preserved in a fluid state, and perfect union; the same force also, promoting and disposing the humors to peculiar secretions and mixtures, according to the different degrees of attrition, and the configuration of the pores of the vessels they are forced through.

And, as the branches springing out of the aorta, are smaller and narrower than the trunk they rise from ; so, it also happens, in these minuter vessels ; the sub-divisions being less, than the vessels they divide from. The last extremities convey the red, thick part of the blood, and pour it into the extremities of the veins ; and the narrower and straighter branches, or extremities, receive the thin, more fluid and transparent parts ; the diameters of their orifices being less, and pressed by a strong, oblique and opposite force.

But this thin, subtle liquor, being separated from the thicker, is no longer blood, but another kind of fluid ; and that too various ; being variously determined in its qualities, by the different forms it receives, either from the impressions of different agitations in the extremities of the vessels, or put on, by a various commixture of spirits, according to the quality, and different configuration of its component particle ; and so 'tis adapted to pass through its several destin'd vessels.

One part of this humor is separated in the form of sweat, or perspiration ; another becomes matter in the pores ; some supplies tears, some a fatish wax, cerumen, mucus, saliva, lymph, serum, bile, seed, oil, fat, milk, &c. therefore the last branches, losing the name of arteries, are differently called, according to the various dispositions of the humors they carry ; though, as they often still retain the properties of arteries, they have likewise all their smaller branches and veins. And thus the arteries and veins are equally serous vessels, and lymphatics, and both carry watry humors, spirits, &c. as well as blood : nor do we know where these vessels terminate ; but hence, at least, we see the rise, progress, end, and office of the lymphatics.



Yet, the branches, perhaps of every such artery, being further divided, but growing strait, and, terminating in the membrane of the finest glandulous cavities, discharge their humors with open mouths, into the common cavity, formed by that membrane; where being reserved together, it in some measure stops, and is called glandulous lymphæ; being there made and collected.

And, 'tis not improbable, the glandulous nerves after a like manner, deposite their liquor, mix it with the lymphæ, and there supply the office which nature requires; enriching it, and making it more spirituous. In the mean time, the lymphatic arteries frequently bring their lymphæ, discharged into their valvulous veins; a lymphæ, which we call vascular, to those glands; and after a different manner, discharge it into their cavity; and, mixing with the glandulous lymphæ and spirits, they subtilize it a fresh.

Then, this compound liquor passing through the lymphatic veins, forced by the contractive power of the fibrous membrane, the motion of the artery and the muscles, is drove again into other glands, there to undergo the like alterations; and, thence tis convey'd into the *Receptaculum chyli*, thoracic duct, and lastly, into the sanguiferous vessels. And these seem to be the conglobate glands of the whole body.

But, in other parts, this is perform'd after another manner; for that small gland expels the liquor it receives, through a proper vessel, into a common cavity; whereas the mucus separated in other parts is deposited, collected, and changed, after it is sent to the sinus's of the *Os Frontis*, the cavities of the upper jaw, the cells of the *Os Sphenoides*, under the *Sella turcica*, the intestices of the spongy bones in the nostrils, the cavities of the nostrils, and the cavernous spaces about the

tonsils; and the like happens in respect of the glands of the mouth, of the back part of the tongue, of the exterior, and internal parts of the epiglottis, the inside of the nostrils, the cavities of the ears, jaws, larynx, *Aspera arteria*, the bronchia, esophagus, stomach, and the mucilaginous glands of the intestins, which may be called simple excretory glands.

Again, others in a like manner, discharge the fluid they separate, through proper vessels, rising from the cavity of a gland, without the skin; as in the external cavity of the ear, near the cartilages of the nose, the wings, and external part of the nose, the beginning of the internal passage of the nostrils, in the face, the back part of the neck, the arm-pits, the shoulder-blades, the pits of the breast, and the region of the navel, the nates and space about the anus, the perineum, the region of the *Pubes*, and the protuberant parts adjacent in both sexes, the *Scrotum*, the skin of the *Penis*, *Labia vulva* and the knees; and these are now stiled sebaceous, or unctuous excretions.

For these reasons, the distance of an artery from the heart, its situation, in respect of the heart as well as of the trunk from whence it rises, and the various complications thereof, the different degree of velocity of the blood through it, and the particular proportion of a branch to the trunk it rises from; this as well as the different force that expels it, either external or internal; the time it stops in the common cavity, and the distribution thence, into places which alter the humors, according to their own different structure, as also the more liquid part, exhaling or being separated; all these causes, I say, concur to produce a vast variety of humors, in different parts, out of the same blood; which being there separated, is thereby wonderfully changed and altered.

For,



For, these causes differ in various parts of the body, acting either separately or conjointly, and are easily distinguished by the fabric of the parts apparent to the senses; or are else deduced from thence, by the most rigorous demonstration the establish'd laws of mechanics afford; and also from the nature of the humors, which may easily be observed, by any one that studiously considers them; which gives us a view of many different kinds of secretions, and different humors separated, which are actually found in human bodies.

So that, from hence, we see how humors prepared by the forementioned agitations, attritions, dilutions, &c. may be disposed to undergo a further alteration, according to the certain, various, and innumerable differences, almost of all the parts, and the pores they are strained through; which may variously determine the configuration of the particles of matter, thus forced or prepared to pass through them, and thus by such a strict compressure, they may be inclined to adhere to one another after different manners; their size and figure, being altered and fashioned into different coalitions or forms, according to their various degrees of subtilty, occasion'd by successive attenuations and attritions, and their new modes of combination; these new forms, producing new qualities different from each other.

There is, therefore, no room, to imagine pores of a determinate, various, and immutable figure, to account for these phenomena; the laws of nature deny all such in the human machine; and were they to be found therein, they wou'd act in a different manner. Nor need we in this case, have recourse to fictitious ferments lodging in the parts, since these attritions, and the intestin

motion of parts, may alone suffice to digest, attenuate, heat, and consequently ferment them; as the particular methods of secretion or percolation, are abundantly sufficient to induce new forms, and consequently new qualities, as will be farther shewn hereafter.

From hence also, we may learn the very manner how these agitations, attritions, and concussions, may divide and subtilize the parts of matter; and assisted by the power of attenuation, rarify and digest the grosser portion; and by violent compressions, increase the intestine motion of the particles of subtilized bodies; as well as by a reverberatory force, that afterwards breaks them all to pieces, which variously uniting with one another, necessarily induce new forms, and consequently, as has been said, new qualities; we also understand from hence, how bodies thus rubbed together, may grow hot or ferment, be precipitated or dissolved, changed and assimilated; for all such effects, may be mechanically produced.

But from these simple glands already described, or others very like them, uniting together by common vessels, and being further enveloped and bound together by one common membrane, those compound glands are formed, which are called conglomerate. These have, for the most part, one common excretory duct, which receives the humor sent into it, by the proper ducts of all the particular glands that compose the whole; and, collecting it all together, discharge it into some larger cavity, such as the *Innominata* of the eye, the parotid gland, the pancreas, &c.

Nay, the excretory vessel of the common receptacle just mentioned, often degenerates into a curved vessel, like an artery, which changes the humors; and then, after the nature of that vessel, discharges them in the cavity ready to receive them.



them. Of this we have an example in the male testes, *Higmore's duct*, the *Epididymes*, the *Vasa deferentia*, and *Vesiculæ seminales*: or, secondly, they presently discharge them into the common emunc-tory.

From hence we certainly know, that the glands not only separate water, lympa, and thin serum, but also salts, spirits, and the most subtile parts of oil mixed along with them; and that all these are either stagnant, collected, and amassed in certain places, or drove through the most minute vessels, into the smallest and finest parts of the body, when they serve for motion or nutri-ment; and thence return, through proper vessels, to the heart, or else transpire and exhale; and lastly, that part of the blood, which remains in the arteries after this is over, gradually passes into the larger veins, to be mixed with the like blood, diluted with lympa, and so return-ed to the heart.

For this reason, the arterial blood, about the heart, is most diluted, and gradually grows thick-er towards the extremities of the arteries, or in the beginning of the veins, where it is thickest, aptest to coagulate, and most viscous; there it requires a vessel not subject to obstructions, and the additional mixture of a fluid to dilute it, that is, of lympa, which having perform'd its office, is returning towards the heart, and also, spirits; and this is necessary to be done, before it is sent again into the pulmonary artery; other-wise it would not be fit to circulate again.

Hence we know, the place where life and health are in the greatest danger to be discontinued; what service the larger vessels, and the grosser humors, the smaller canals, and the more subtile fluids are of, to render the body strong, firm, flexible, and fit for motion; we may likewise

hence know the reason why the veins conveniently grow gradually larger, lax and free for the motion of the fluids, fit and apt for diluting; and why this happens before the return of the blood to the heart.

Some glands, however, seem to be of a different fabric and contexture; so that the artery, which conveys the humor, communicates the grosser blood to the vein that attends it, by anastomosis, opening out of the artery into the vein; and then, proceeding alone, folded in wreaths, ouzes out of its extremity, into a common receptacle, a particular humor prepared from the blood, though of a different nature thereto. See *Leal Lealis* of the spermatic vessels.

When, therefore, *Hippocrates*, *Wepfer*, and *Malpighi*, compared the cortical part of the brain, carefully viewed, with the fabric of a gland, from its similar appearance thereto, they thought it truly glandulous; but *Malpighi* says, the glands here are of an oval figure, but pressed angular by one another, being small, curved, and joined to others something bigger than themselves; and these growing together form still larger, so that a vast number of these, collected and heaped together, make circumvolutions, like those of the guts, whereby the external part of the cortex of the brain is formed; so that the smallest branches of the carotid and vertebral arteries, being here twisted and interwoven into the form of a gland, might separate, through their very minute and innumerable orifices, the most subtle humor forced therein by the arterial blood; and discharge it gradually into its cavity; from thence to be drove successively, by the subsequent fluid, into the proper excretory vessels; the rest of the blood being returned into the sinus, by the veins.



The natural eye, and microscopical observations, favor *Malpighi's* opinion; which is farther confirmed by the brain appearing divided into little globular parts, like glands, upon boiling; as also by pouring ink upon it, and wiping it off again, when the cortical part of the brain represents rising *Moleculæ* divided by small chinks: the brain likewise, sometimes, when distemper'd, is concreted into stones, resembling mulberries; when corrupted by contusion, it rises up through the aperture of the broken skull, in a glandulous-like fungus; and in a dropfy, the external parts of the brain are elevated, like so many spherical bodies: all which evince, that there is a like structure here, though more fine and subtile, than in the other glands of the body.

But whether the last little branch, which forms the extremity of the vessels, be a direct continuation of the fibrous substance of the brain, as *Ruyfche* asserts, cannot be determined by any valid argument; these vessels being so small, that they quite vanish from the sight: nor could *Ruyfche* himself, with his most curious injections, ever tincture the medullary part of the brain red; but it always remained exceeding white, though the other parts were fully injected: but, notwithstanding this opinion seems highly probable, for many weighty reasons to be offered by and by, yet the effects are nearly the same in both cases.

The extremities, then, of these capillary vessels, or the little glandulous membranes they terminate in, send out small white, fibres, closely compacted together; which united, make up a callous medullary substance, that lies under, and adheres, close to, the cortex, both in the cerebrum and cerebellum; so that, wherever the cortical part terminates, there the callous or medullary part begins.

But

But in whatsoever way these two parts communicate one with another, the cortical machine is so conveniently accommodated to the medullary part, that it adheres not only to the cerebrum and cerebellum, but also to the outward appendices of the *Corpus callosum*; and is continued along with the ventricles, even to the rise of the spinal marrow, and the oblong tract of the same, without the brain; but so, that the cortical part is included in the medullary part, by a sinus, interposed in the middle thereof, and is there furnished with a vast number of arterial ramifications.

And so, in every part of the whole brain, where there are small arteries, though invisible, there must needs be invisible veins to attend them; but a great quantity of spirits, being separated to supply the vast number of nerves, distributed through the whole body, makes the less number of veins necessary, as there is the less quantity of humors to return by them; this cortical part being found, in all the recesses, circumvolutions, openings, interstices and appendices, as well as in the external superficies of the brain towards the skull.

Since then, some of the medullary part rises from every point of the cortical, it must needs be very small at its origin, but, joining to other parts like it self, it grows gradually larger, and, at last, becoming sensible, forms the medullary part of the brain, the callous substance, the expansions of the *Medulla oblongata*, called *Crura*, the *Thalami* of the optic nerves, the *Medulla oblongata*, the protuberances, as well as the medulla of the *Cerebrum*, and the parts produced therefrom, and inserted into the *Medulla oblongata* of the brain; which, joined by these productions, is extended into parts of a pyramidal and olive-like figure,



figure, and continued to the spinal marrow, even as low as the second vertebra of the loins, but is then divided into distinct nerves, by a coat continued to the *Pia mater*, and with what is added, resembling a horse's tail; and from this medullary substance, both within the skull and the cavity, formed by the united *Vertebrae*, all the nerves, in general, take their origin.

But that the filaments, which compose these nerves, are first separate and distinct from each other, though, when joined, they seem to compose one body, is evident, to any one that considers, *First*, their origin, composition and progress, till they come to divide. *Secondly*, the brains of fish, hares, sheep and oxen, either crude or boiled; in which, the cylindrical fibres manifestly appear depress'd, and to lie aside one another, like the teeth of a comb. *Thirdly*, the small sanguiferous vessels, interwoven betwixt those fibres, make an evident distinction and division. *Fourthly*, the cortical part of the brain, is placed in the very middle of the ambient spinal marrow. *Fifthly*, the white fibres, dispersed thro' the middle of the cortical part, in the back of the spinal marrow, whilst it yet remains within the skull, and at the sides of its origin, and chiefly in the appendixes of the callous substance, and in the cerebellum it self. And, *Sixthly*, that these medullary fibres are collected and dispersed in the *Medulla oblongata*, and from thence into the nerves.

The course, then, of these fibres seems to be this, *First*, rising, in distinct, slender threads, from every side of the spherical, cortical part, which encompasses the medullary, they tend, as it were towards the center, and first form the *Medulla*; but, soon bending backwards from one another, they are collected above, in the

*Corpus*

*Corpus collosum*, and the *Fornix*; but below, compose the fore and back part of the *Crura* of the *Medulla oblongata*, as also, the annular protuberance. Secondly, rising from the *Cerebellum*, after a like manner, and being collected together, they join to the former collection, and unite therewith three different ways. Then, Thirdly, all of them, from their two distinct origins, uniting into one common bundle, form the spinal marrow alone. Fourthly, the like sort of slender fibres, rising, on every side, out of the cortical part, placed within this medullary, from every point thereof, tend to the internal and hollow superficies of the medullary part, and, rising therewith, add to its bulk.

Since, therefore, this appears to be the fabric and structure of the parts, the reason of the quantity, figure and situation, of the cortical part is evident; it also appears, that these advantages could not be obtained, without such cavities and ventricles; the necessity appearing from the good office they perform, by preventing mutual impediments in every part of the brain, the whole medulla being thus at liberty; and from hence, the origin of the protuberances are manifest, which appear in various places of the marrow; a new supply of medullary fibres arising from different parts.

But it is very probable, that the medullary fibres of the *Cerebellum* rise from the lower part of its juncture, and ascend upwards towards the fore part of the *Medulla oblongata*, bestowing some fibres, also, to those nerves, which arise from the marrow of the brain; an actual distinction of their rise, progress, and office being constantly observed; for, this is very evident to any one who considers the various insertions of the medullary part of the *Cerebellum*, into the *Medulla oblon-*



*oblongata* of the brain, and the increase of the bulk, proceeding from that addition; it farther appears, from the consideration of the spinal nerve it self, going back again, out of the cavity of the *Vertebræ* into the *Cranium*, to join there with the nerve of the eighth pair: but the rest of the fibres of the *Cerebellum*, are so mixed with the sides of the brain, that, perhaps, there is hardly any part of the whole *Medulla oblongata*, or spinal marrow, where there are not fibres of the *Cerebrum*, as well as of the *Cerebellum*, mixed together; and, therefore, may both concur to form the body of every nerve, for quite different and distinct effects.

Whoever considers, *First*, the nature of the cortical part, as already explained, and, that distinct medullary fibres arise from thence; *Secondly*, the similitude of the structure hereof, with that of all the other parts of the body; *Thirdly*, the great quantity of the thinnest, most pure, and volatile, arterial blood, not yet deprived of its more subtle part, and drove hither with great force from the neighbouring heart. *Fourthly*, the most thin humor, discoverable in the medullary part of the brain dissected, either by the tast or sight, but especially by microscopes, which is often much increased in distempers of the brain. *Fifthly*, that the veins from the *Pia mater*, the cortical part of the *Cerebrum* and *Cerebellum*, bring back the blood, discharged in the sinus's, to the heart through the veins. *Sixthly*, the constant, regular, and proportionable increase and nourishment of these *Stamina*, with their branches and reductions, from the first beginning to the period of life: I say, whoever considers all this, will judge, that these fibres are small, pervious tubes, which receive into them the most subtle fluid in the whole human

man body; which, being prepared in the most wonderful structure of the cortical part of the brain, separated in the same, and drove with force into these tubes, is collected from all the parts thereof in the *Medulla oblongata*.

And if we again consider, the disposition of the blood, forcibly brought hither, through the carotid and vertebral arteries, and the difference betwixt it and that fluid; and, *Secondly*, the most delicate structure, which even terminates, or disappears, in the most slender and invisible winding extremities, and the finest membranes, which are so soft, that they fall in pieces almost of their own accord: and also, that the arteries, which rise from the carotids and vertebrals, composing the cortical part, with so fine a texture, that it is impossible to trace it. And, *Thirdly*, the particular nature of that humor, which, being contained in these vessels, presently exhales of its own accord; nor is coagulated by the action of fire, but totally vanishes into the air; whilst the rest of the fluids, in a human body, coagulate by heat, or leave many feces, or dregs, behind them. *Fourthly*, if we take notice of the force and celerity, which daily observations teach us, from the effects of this fluid, both in the nerves and muscles; we may easily allow, that the parts, which go to compose it, are the most solid, volatile, simple and fluid, of all the humors in the body.

But the red part of the blood, when viewed through a microscope, appears to be the thickest of all the natural humors of our body; in the mean while, the serum, whose parts are much thinner, may be divided into corpuscles, vastly less in bulk, as appears in the first rudiments of a fetus in the egg, after incubation; where the hu-  
mor



mor of the white is so successively attenuated, till it become fit to flow through all the vessels of the embryo, which are so small, as to exceed imagination; and, in insects of the least kind, an infinite number of different vessels are penetrated by their own humors, much less, than which are perceivable in *semine masculino*; whence it will easily appear, that the parts, of that most thin and rarified fluid, are much less, than is commonly thought.

And we may say, that this humor is of a much stranger nature, than what can be obtained from salts, produced by any art whatever; because, in all its properties, 'tis vastly different from them; much less, can any oils, yet known, be made like it, since they are very disagreeable and hurtful to the pores of these fibres; nor is it like any spirits, procured from any vegetables by fermentation; because these, when esteemed good, dry the fibres up, and presently render them unfit for their office. Wherefore, the spirits of the most subtle water, perhaps, are more agreeable, and of a like kind hereto, since it resembles them in its aptness for mixture, motion, solidity, softness, simplicity and want of elasticity; the change, however, of the liquor in an egg, upon incubation, shews us, that they are produced from other matter.

Again, we are satisfied there is a great quantity of this humor, and that it is new made every moment we live, in health; for the bulk and magnitude of the carotid and vertebral arteries, and their direct course, meeting with no obstacle, the great quantity of blood driven thither, the greater motion whereby 'tis forced, and the largeness of the cortical structure, make this very clear.

But

But though the animal spirits, differ so widely from other spirituous substances, and are so extremely fine, when separated, and kept in a constant motion, as the blood it self keeps fluid, whilst briskly agitated, yet, as that, when cool, falls into a gross coagulum, so the spirits, when void of motion, and exposed to the air, presently lose their agility and tenuity, though they do not run into so gross and tough a substance as the blood; being much more soft, and of a less clammy nature, as appear by the sweet oily mucilaginous tast which the nervous juice affords in the substance of the brain, and spinal marrow, after death.

And that this is the real nervous juice, separated from the arterial blood, is evident by the likeness of tast it hath with the blood from whence it comes, and whereinto it is again returned by the nerves; for, though they differ both in color and degrees of fineness, yet the blood retains the sweet tast of the spirits, and the spirits preserve that quality separated from those, which still remain in the blood.

And that the substance, we can thus tast, in the brain, is the spirits separated from the mass of blood, appears also from the effects consequent upon their action and use; for we find that those muscles, into which they most plentifully flow, and which perform most motion, are always sweetest, and retain the greatest share of that quality; which is necessarily communicated, by the spirits making such frequent incursions into their fibres; thus we see the muscles of the eyes, and those which serve in mastication and respiration, are sweeter than those which only act in voluntary motions.



If the actual existence of a fine, subtile fluid, in an animal body, called the animal spirits, or nervous fluid, be still doubted, the following experiment may demonstrate it not chimerical. If the diaphragmatic nerves in a live dog, be laid bare, and slightly pricked or vellicated, the diaphragm thereto adjoining, will be suddenly contracted, and become plain. Now, this sudden convulsion of the diaphragm, must necessarily be caused, either by the motion communicated to the nerves, and so continued to the diaphragm; or else by means of a fluid, which flows the faster upon this stimulation. But, if these nerves be first tied fast round, and even a greater force applied to stimulate them, no contraction or motion of the diaphragm will succeed; it follows, therefore, that the said convulsion of this part is owing to the influx of a certain liquor into these nerves: which ought to be understood of all the other nerves in the body; since we find, by experience, that, if any of them be struck, the muscles, they belong to, will be convulsed; but if these nerves are tied up, the muscles relax, and become flaccid.

The whole brain contains all things necessary for the preparation of the spirits; and is enclosed in a strong bony case, to defend so curious a part from accidents, where such a fine and spirituous substance is prepared for such noble ends. Since the brain is so noble a part, and designed for many extraordinary purposes and uses, not only to prepare spirits so necessary, when distributed through the nerves, to all the animal functions; but also to be the seat of the mind, and the chief organ of the soul; there was no necessity it should be clogged and incumbered with a quantity of fat, muscles, or any other substance to defend it; for these would but incumber and

disturb the more refined actions and ends it is designed to promote: being, therefore, free from such incumbrances, it is allowed the full exercise of its own actions: and its arteries and sinus's being also, by the same means, constantly preserved safe, they are capable of performing their office without interruption or hindrance.

Whilst the brain thus performs its office, the *Medulla oblongata* and spinal marrow, consisting of medullary fibres collected together, send forth within the skull, in twenty different places, ten, falsely called, pairs of nerves, most of them consisting of many distinct and large nerves joined together; and from the spinal marrow without the skull, and in the cavity of the *Vertebræ* of the spine, thirty pair of nerves take their original, being greatly compounded; and one pair, rising out of the cavity of the spine, about the fourth pair of the vertebral nerves, along with branches from the second and third pair, that gradually increase its bulk in its ascent, is joined to the eighth pair.

All these nerves, whilst they remain amongst the substance of the brain or marrow, are of a pulpy consistence, but, going out thereof, covered with an expansion of the *Pia mater*, or a membrane much of the same nature therewith, they pass to the *Dura mater*, which is perforated and extended into canular coverings, reaching as far as the perforations of the skull, which the nerves pass through; and having this membrane added to the former, the nine first pair, together with the accessory pair, all enter their perforations, and are continued through the skull, after a wonderful manner; being safely guarded by their external coats. But the other thirty pairs, and one, which joins with the eighth pair, descend broad, through particular spaces, betwixt the commissures of the



apophyses of the *Vertebræ*; and, rising from thence, firm, hard, and well defended by membranous integuments, they are dispersed through all the most minute, solid points, of the known parts of the body.

The coats of these nerves are every where furnished with blood-vessels, lymphatics, and others, closely interwoven; but they do not make up part of the real nerve, though, they serve to bind together, and strengthen the fibres thereof, and help to nourish them. By being acquainted with this distribution, we may learn to understand many phenomena, and diseases incident to the nerves.

But where the extremities of the nerves, entering into the parts they belong to, again put off the coats they were before covered with, they are presently expanded into the form of a fine, thin membrane, or soft pulp.

If, therefore, we attentively consider, *First*, that the whole marrow, being vascular, is employed, and spent in the supply and composition of the small nervous fibres; and, that they are wholly continued into them; *Secondly*, that the *Cerebrum*, or *Cerebellum*, being compressed, divided, putrefied, or corroded, every action, that was before performed by the nerves rising from thence, is presently abolished and stopped, although the nerves remain in the same condition, and unhurt, in respect of their membranes; *Thirdly*, that the nerves are always loose, suspended, curved, and winding backwards obliquely, and yet, most readily perform their office in the actions of sense and motion; and *Fourthly*, that, being pressed or tied together, though they remain intire, the person loses the faculties of sense and motion, in the parts that lie betwixt the ligature and the extremities,



or those to which the said nerves are directed; the communication being lost betwixt the place of the ligature, and the cerebrum and cerebellum: I say, if we consider these things, we must needs conclude, that the fibres of the nerves, at their origin in the marrow, receive, transmit, and transport this humor, to every point of the whole body, in distinct vessels; and, by this means, alone, perfectly discharge and perform their office.

Nor, can that opinion be of any validity, which asserts, that the nerves act by a vibration, depending on the strict tension of its fibres when struck; since it is quite contrary to the nature of a soft, pulposus, flaccid, or slack nerve, often curved and bent; and inconsistent with its use, as an instrument of several distinct sensations, and an active cause of muscular motion; therefore, the arterial blood and lymph, constantly circulate through the veins, arteries, and lymphatics; whence we find that the fluid prepared, and separated in the cortical part of the brain and *Cerebellum*, is continually drove from those parts where it is received from the cortical structure, through the nerves, into all the points of the body, by the force of the heart, and arteries.

The subtilty of *Ruyfche's Tomentum vasculosum*, or vessels in the cortical part of the brain, which, are, chiefly, nothing but arteries, and consequently immensely thicker, than the last lateral, excretory ducts derived from them, teach us how prodigiously minute these nervous tubes must be: but the great bulk of the brain, compared with the smallness of every fibre, demonstrates their number beyond the bounds of imagination; besides the great quantity of humors, constantly and forcibly drove hither, certainly  
implies



implies that these small canals must be always open, kept full, and be in constant action; yet, we do not suppose the velocity of this liquid through the nerves to be violent; for the number, smallness, curvature, and texture of the arteries, as well as the number, minuteness, and winding course of the nerves, together with their hardness, which is also various in different places, convince us that its motion, though constant, must be equable and gentle.

It is no wonder then, that the eye cannot perceive the motion of this liquor, or, that it is not to be exhibited by means of ligatures, wounds, punctures, blow-pipes, or injections; or that the cavities of the nervous fibres should be invisible; for if we consider the nature of the vessels, and of the humor, these things are not to be expected; he, therefore, who denies the cavities of vessels, because they are too small to be visible, and too fine to be discovered by art, must be ignorant of the rise, progress, operations, and excretions in human bodies, and the structure of insects; nor, lastly, can he have observed what manifestly happens in plants.

It is then a gross error, to think that the thick lymph, which distils from the nerves of an ox's tail when cut, is the liquor we here speak of; nor can any artificial fluid, injected into the carotid artery of a live creature, by tinging or staining the nerves, demonstrate their cavities; no more does a tumor that rises upon making a ligature on the nerves of a young person demonstrate it.

This liquor, by reason of its simple qualities, subtilty, and volatility, when its parts are put in motion, we call the spirits of the nerves; and it is either natural, vital, or animal; of which in their proper places.



But, since fresh is supplied every moment, and the first pressed forwards, by the subsequent part, that which latest performs its office, seems to be drove out of the last fibres, into the small lymphatic veins, about the glands and elsewhere; whence 'tis conveyed into the larger lymphatic veins, and from them, into the common lymphatic vessels; which being furnished with valves, are as veins, and from thence, 'tis carried at length, into the veins and to the heart; and so the animal spirits as well as other fluids, are in a constant circulation: but whether it is more probable this fluid should be stopped, and remain in some unknown places; returned back from whence it originally came, be discharged out of the blood, through the pores; or lastly, returned into the blood again, we may see from what hath been said, and will be further manifest hereafter.

The blood being, at last, deprived of its spirits, separated in the cerebrum and cerebellum, is forced forwards into the veins; out of the veins into the sinus's, or the great receptacles of the veins, and thence, without any artery attending them through the perforation of the skull, into the venous protuberances, from thence, into the internal jugulars, through the subclavians, and *Vena cava*, into the heart.

The lymph here, as in other places, separated from the arterial blood in every part, both of the cerebrum and cerebellum, and all that was continually discharged into the ventricles, returns back into the lymphatic vessels of this part; into the *Infundibulum*, the *Glandula pituitaria*; and, this is also continually circulated through the several parts of the brain.

From what hath been now delivered, we may understand, why the cerebrum and the cerebellum, with their appendices are inclosed by bones, as in  
a box,



a box, and what service this is of thereto; why the spinal marrow is included in the cavity of the *Vertebræ*, and why it hath neither muscles, glands, nor fat; why the carotid and vertebral arteries pass not along with the veins, but distinctly, by themselves, through other different perforations, at a distance therefrom; why the blood is discharged into sinus's within the skull, situated in particular places; and why it does not pass directly out again; why the veins empty themselves into the sinus's, in opposite directions; why the figure of the brain is spherical, and of what use the ventricles are therein; of what use the *Plexus choroides* is, of what service the *Falx*, and the other process of the *Dura mater*; why the cerebellum hath no ventricles, and why it is separate, and placed in greater security than the cerebrum; why the soft body of the nerves, going out under the substance of the cerebrum and cerebellum, are not compressed thereby, but pass out unresisted; and, lastly, whether the origin and extremities of all the nerves, lodge in the *Glandula pinealis*.

Whoever thoroughly considers all this will see, that these parts are formed with consummate wisdom, so that the fluids circulate, and are separated equally without any hindrance, whilst the heat of the arterial and venal blood is constantly preserved, which would otherwise be lost in the minute vessels; and, also how commodiously the lymph is returned and mixed with the venal blood, let the head be placed in what posture soever.

But the blood having perform'd its office, and returning from the brain, 'tis diluted with lymph in that part, mixed with new chyle, lymph, bile, venal blood, and perhaps spirits also, which are then poured into the veins again; and being thus received by the heart, it is forced into the lungs, where it is altered, renews its former disposition,

before it goes again, provided it be not crude, to the brain; and though nothing new be added thereto, this preparation alone, will render it apt to afford a fresh supply of spirits, by means of the cortical structure of the cerebrum and cerebellum; 'tis, therefore, probable, that some part of the mass of blood, may constantly pass and repass this way, without mixing with, or partaking of the disposition of the rest; one portion as was formerly said, being more rarified, attenuated, and volatile than the other; and so only undergo a more frequent, quick, and equable circulation through these vessels.

Lastly, if we consider the great bulk of the *Cerebrum* and *Cerebellum*, the *Medulla oblongata*, and the spinal marrow, compared with the real solid dimensions of the rest of the body; and observe the great number of nerves that spring from thence, and are distributed through the whole machine; the brain and spinal marrow, appear the most extensively necessary, and superior, curious pieces of workmanship, specimens of skill, and contrivance of the whole body. For, these parts, according to the observations of *Malpighi*, are the basis of the whole structure in an embryo; and hence all the other viscera proceed; nor, indeed, is there any part of the body, which hath not either sense or motion; and all the solid particles thereof are full of nervous fibres, interwoven through their structure. Is it, then, absurd to think that the least vessels, over all the body, which rise last from an artery, become very like to the most minute fibres of a nerve, both in magnitude, the humor they contain and other properties?

That part of the blood, which is sent to the head by the lateral arteries, and not employ'd in preparing spirits, is distributed through the *Dura mater*, the *Cranium* and *Pericranium*; and  
also



also to the muscles, and other parts about the skull. The *Dura mater*, being the internal covering of the skull, is the basis from which these arteries send their branches to the bones of the *Cranium*, and disperse their small twigs every where through the same; and these, being distributed through the *Diploe*, betwixt the two tables, and meeting with others, form small plexus's, that afford it nourishment, warmth and marrow, which is separated in the diploe, and promote the growth and increase of the bones, proportionably to the increase of the parts contained: and when this is done, the blood returns again, by the veins, with great velocity.

After this, the blood, which appears much like that sent to the head, in consistence, fluidity and aptness for motion, is drove into the subclavian and axillary arteries, and those of the arms and hands; where it performs its office, being drove through the smaller vessels, by promoting agility, strength, motion and heat, as well as affording matter for sweat; for which reasons, it must flow quick through those parts: and here, as well as in all other places, the blood, which is brought by the arteries, and strained through the smallest canals, is distributed to the bones, marrow, membranes, muscles, fat, glands and skin; where the vessels, becoming invisibly small, return it into the veins, which, gradually enlarging, convey it to those of the hands and arms, the axillary, subclavian, *Vena cava*, and so to the heart.

For we must observe, that as at the extremities of all the small arteries, so here also, there is a sort of small, glandulous machine, or texture of canals, from whence a vessel rises, to receive the humor there secreted, whether it be lymphatic, serous, or of an oily nature; which,  
being



being brought again from thence, and poured a second time into the blood, and mixing therewith, they are both returned back together, by the veins, into the heart. This is evident from hydropical cases, especially an *Anasarca*, lymphatic tumors of the parts, upon making ligatures on the veins thereto belonging, fistulous ulcers, *Hydatides*, *Phlyctenæ*, the itch, and also, from the knots, like barley-corns, that are very frequently found amongst the fat; and the like accidents happen in all parts of the body.

Next, that part of the blood, which has a more curious texture, is, as well as the grosser, carried, by the laws of hydraulics, into the descending trunk of the aorta; and the finer part, entering the intercostal arteries, and having performed its office with great celerity, is agitated and rarified, by attrition, in the intercostal muscles, by means of their constant motion, which comminutes and rarifies it the more, but causes its stay there to be the shorter, and the circulation in those parts quicker; the blood, forced in by the arteries, being instantly compressed by the contraction of the muscles, and emptying the larger vessels, thereby make them readier to receive the blood out of the relaxed fibres; and thus accelerates the motion of it successively into the vein, called *Sine pari*, which carries it into the *Cava*; and so it again returns to the heart. By the admirable contrivance of these vessels, the circulation is, likewise, render'd exceeding free, without any hindrance or obstacle from the great quantity of blood in the *Vena cava*; for the parts that discharge themselves into that vein, for instance, the intercostal spaces, and the greater part of the membranes placed in the thorax, will not bear any obstruction, without the greatest imminent hazard of life: and, for the same reason, there is here a free passage, out of  
the

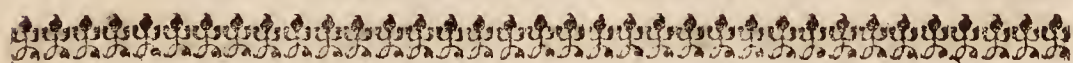


the arteries into the veins, which shews the reason for the blood's velocity, and why acute diseases are so frequent in these parts.

After these, the phrenic arteries, and those called pericardio-diaphragmatic, receive the like blood with the intercostals, and the vertebals; which, passing swiftly through them, is emptied into the phrenic veins, and thence conveyed into the cava; and these, also, conspire to render the circulation free, swift and constant.

The *Aorta*, then, passing through the diaphragm, descends to the loins, the abdomen, thighs, legs and feet, after the manner already mentioned; and the blood, having there likewise performed its office, it returns through the veins, which are furnished with valves about the lower parts, to support the weight thereof in the larger vessels, and hinder it from pressing upon the smaller, which might, by that means, retard, and render its reception out of the arteries more difficult; and thereby occasion stagnations, and other ill effects.

And from the same trunk, under the diaphragm, branches of arteries are distributed to all the viscera in the lower belly; and serve for different purposes, divisible into the preparation of chyle, and the separation of feed and urine; having all a glandulous contexture, wherein their action chiefly consists.



## C H A P. X.

### *Of the Action and Use of the Spleen.*

**T**H E situation of the spleen, its nearness to the celiac artery, its use in respect of another part, and the tendency and motion of the fluid

fluid that flows from it, requires that we should now consider its use and action.

It is placed in the left hypochondrium, suspended from the diaphragm, adheres to the left kidney, and omentum, and, in some measure, to the stomach. It easily gives way, and admits of a great variety of pressures, and is continually moved upwards and downwards, by means of the diaphragm and muscles of the abdomen.

It receives pure arterial blood, forced immediately out of the heart, from the first considerable branch of the celiac artery, which rises under the diaphragm, from the aorta: whilst the first branch sends out this twig, the third branch often sends three others, which join it; but sometimes the artery is distributed from the aorta after such a manner, that the liver, the pancreas, the gut called duodenum, and the stomach, are supplied with ramifications from the same vessel with the spleen; whence it appears, that the blood, distributed to all those parts, is of a like kind.

These arteries, which are large, and much bigger than those dispersed through the liver, as soon as they enter its substance, are distributed through the whole body; the spleen being divided into a vast number of small branches, that terminate in small tubes, which are so joined together, as to appear like small glands, and vanish every where about the extremities of the splenic vein.

Comparative anatomy in men, oxen, sheep, moles, hedgehogs, and morbid bodies, where this part abounds with strong tubercles, as also, the appearance of the same, when macerated, render it not improbable, that the extremities of its arteries degenerate into, and compose glands. And though the artificial way, of filling these vessels by injection, teaches us, that there is a direct passage  
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out of the arteries into the veins ; yet the extremities of all the arteries, in the substance of the spleen, seem not to terminate after the same manner, but considerably different from one another ; which, notwithstanding, cannot be demonstrated to the eye, by reason of the crispy tenderness of the extremities of those vessels.

It is evident, however, that the structure of these parts is the same, as that of all others in the body, where secretion is performed ; yet there is no common vessels sent out of the substance of the spleen : it farther appears, that the lymphatics, which are found there upon the whole external membrane, pass only betwixt the two membranes of the spleen, and also, here and there from the splenic artery, are fewer in men than other creatures ; nor do they rise from the inward substance of the spleen, and the extremities of the arteries, but from those vessels which serve to nourish the substance of the spleen.

And since comparative anatomy teaches us, that the like structure is observable in most brutes, it is very probably, the same in men's bodies, though not here so easily demonstrated to the eye ; such, however, it is in calves, &c. The splenic vein, which is very large, as soon as it enters its substance, sending branches every way throughout the whole of it, hath very apparent perforations ; and, being distributed further, almost disappears about the extremities of the arteries, as does likewise the nerve ; whence it is manifest, that this vein is fill'd both by the extremities of those vessels, and the larger, lateral perforations, and so draws in, by its extreme venous inosculations, the blood return'd from that glandulous substance ; and that, through those great orifices in the venous sinus, it admits that liquor which may be there evacuated from the adjacent receptacles ; the whole  
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substance of the spleen being closely compacted and held together, by strong, transverse fibres.

If, when the spleen is well washed, air be blown into it, whilst the splenic vein remains very closely tied, it will be dispersed throughout the same, and discover the whole substance thereof to be porous, and full of cavities which communicate with each other; and if, then, the artery be also tied, and the spleen dried in the air, besides arteries, veins and nerves, abundance of empty, distinct cells will appear, consisting of membranes standing in an erect posture, very different both in size and shape; which also manifestly communicate with one another, and with those lateral perforations in the sides of the veins.

The sides of the membranes, which form the fore-mentioned cells, are furnished with small arteries, and a great number of little, soft, white substances, of an oval figure, dispersed through those membranous substances, that appear like glandulous clusters; and though they, in every sensible respect, resemble glands, yet *Ruyfche* takes them for the pulposus extremities of the small arteries, mutually interwoven with one another: these, however, by retarding and obstructing the quick motion of the blood, may give its parts a different motion and coalition, and thus transmute and alter the temper and disposition thereof.

The spleen is also furnished with a great number of large nerves, but it hath scarce any sensible motion; nor is it endowed with any considerable degree of feeling; exquisite sense being not here required: it is, therefore, very probable, that the tubes, which are contained in its substance, convey a peculiar kind of juice thereto, and mix it with the venous fluids; or give the blood a new disposition or quality, before it passes into the veins.



From hence it appears, that the primary action of the spleen is, that the arterial blood, being pure and plentifully stocked with lymph, should prepare that subtil fluid in the smallest glands, and separate and pour it out, through their proper emissaries, into the above-mentioned cells; and, perhaps, also protrude and thrust it forwards into the splenic vein. *Secondly*, that the remaining part of the blood, being received by the small capillary veins, should, by them, be continued into the common splenic vein. *Thirdly*, that the rest of the arteries, which cover and are dispersed thro' the sides of the cells, there deposite the blood that is attenuated in the arteries, and well stored with lymph, into the open cavities of the cells, as we observe they do in the cells of the penis. *Fourthly*, we suppose, that the nervous juice is plentifully brought and laid down there, when 'tis mixed and continually supplied afresh. *Fifthly*, all these humors, being thus prepared and blended, and, in some measure, stagnating, or being retained for a moment, are, by the joint force of the arterial blood and nervous juice, as also, by the contraction of the two proper membranes, the case of the spleen, and the constriction of their fibres, here very numerous; likewise, by the agitation and motion of the diaphragm, muscles, vessels and viscera of the abdomen, pressed together, mixed and attenuated, as in the substance of the lungs.

For which reasons, the blood being thus attenuated, subtiliz'd and render'd fluid, and abounding also with lymph and spirits, will not easily coagulate, being intimately mixed, nor fall into heterogeneous parts. And thus the judicious *Boerhaave* supposes the blood becomes of a red purple color, before 'tis forced out into the large splenic vein.

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But since the spleen, to the sense of taste, appears of a sweet mucilaginous nature, it may be supposed, that the chief alteration the blood receives herefrom, is that the volatile, oily part thereof, being sheathed by the mucilaginous ones, may, by the force of compression, attrition and comminution, as before mentioned, together with the nervous juice, which is of a like sweet, oleoginous and balsamic nature, be so much exalted, subtiliz'd and rarified, that acquiring this predominant quality; and the parts of it, when thus alter'd, being pressed into the splenic vein, and thence conveyed, by the *Vena Portæ*, to the liver, will be render'd more fit to yield a bileous, bitter substance; since it is observed, that sweet things, even in the stomach, are easily turned into bitters: much more must this happen in the liver, where the particular office of the part, is to yield and prepare such a bitter fluid, to be conveyed to the intestins, where it exalts the digestion of the chyle, and lays the first foundation of sanguification.

It being then very probable, that this is the use and office of the spleen, we may observe, that it wants no proper excretory vessel, to convey the humor thus prepared, as the other viscera have; but the whole, thus mixed and subtiliz'd, is protruded, by the force of circulation, into the splenic branch of the *Vena Portæ*.

Whence it appears, that no advantage from all this action of the spleen, accrues to the part itself: but since all the humor, thus prepared, is conveyed, by the *Vena Portæ*, to the liver, it follows, that the use of the spleen is to assist the liver; and, consequently, what that is will more fully appear, by considering the office and effects of the liver.



Many things, otherwise very obscure, may be easily explained from what hath been observed of the spleen. Hence we know the design of its situation, bulk, and vicinity to the heart and liver, pendulous posture, and loose connexion; with the action of the adjacent parts thereon.

Hence we also learn, the reason of the situation, origin, and capacity of the splenic artery; why, when the spleen is cut away, a creature is more falacious than usual, and how long this effect will last, from considering the situation of the spleen; why, when the spleen is cut out, the creature often makes water; which appears from the situation of the venal artery; from hence it is likewise manifest, why such a creature is very voracious; regard being had to the celiac artery; hence also we may conceive, why, in a few days after this operation, the creature is subject to an eructation of wind, vomiting and loathing; for this becomes evident, from the same observations, and the situation of the stomachic and splenic nerves.

It farther appears, why the right hypochondrium swells, and the liver increases, upon the loss of the spleen; as also, why splenetic and hypochondriac persons are attended with all the symptoms mentioned; why they are pale, and why so subject to laughter.

We may then reasonably ask, whether the spleen be formed only to make a due balance, or preserve the symmetry of the body? whether it is an useless load, and an oversight in the formation of animals? whether it serves as a sink, or receptacle for the black filth of the blood? whether it be the cause and source of vital heat, to animate and invigorate the action of the stomach? whether it be the seat of luxury and venery, both waking and sleeping? whether its distempers prove a damp to venery, or cause sterility? whether the pleasure of sleep consists herein, or rest be promoted by it? or lastly, whether the antients, with more justice, assign'd it as the cause of laughter, joy and mirth? These dreams all vanish at the sight of

*Malpighi's* observations of this part; nor is it more probable, that the spleen drinks up the nerves bestowed thereon, and distributes its own substance, the spirits, there prepared; or, that the whole mass of blood should receive from hence more than a general perfection.



## C H A P. XI.

### *Of the Use and Action of the Omentum.*

**W**HILST the blood, prepared in the whole substance of the spleen, is at length discharged, by several venous vessels, into the great splenic branch, to be conveyed, through the *Vena Portæ*, into the liver; other venous blood, conveyed from the omentum, by its proper vessel, is constantly mixed therewith, in its passage thither.

If we consider the connection, situation, structure, insertion, and tenuity of the omentum, which is like a spider's web, or the finest silk, according to *Malpighi*; and compare it with what hath been discovered by anatomical industry, employed about the various bodies of brutes, we shall find, that, from the arteries of the omentum, distributed into most curious plexus's of net-work, through the little membranous bags that contain the fat, and which there terminate in small veins, placed in the same order, by means of the lateral emissary vessels, in the sides of those little bags of fat, a certain subtle, thin oil is there separated, collected and retained; till, at last, this oil, thus collected, is expelled and forced out of these bags into open ducts, which convey it even to the liver; where 'tis mixed with the blood that comes thither from the spleen.

It also appears probable, that, by the apertures of innumerable very small vessels, distributed thro' the omentum, having membranes incredibly thin, and  
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lying all over the superficies of that part, an exhalation, extremely subtle, and apt to transpire, and be imbibed again, insinuates it self into the whole omentum, in the form of a rarified vapor; which, by the heat of the belly, continually arises from that most subtle dew, distilled therein, through the fine mouths of the exhaling vessels; by which the superficies of all the parts, contained in the abdomen, are constantly kept warm and moist; and this humor is justly said to be most subtle and volatile, as we may learn from its nature and origin, and the scent upon opening the abdomen, as well as from the perpetual consumption and restoration of it.

But since the omentum, in man, is not observed to have any other excretory vessel, except two veins, called *Epiploicae*, right and left, it is very probable, that all the blood of this part, being well impregnated with lymph and oil, is wholly conveyed to, and mixed with, the blood that flows to the liver; from whence we may gather the reason, why the caul grows so big and fat, in bodies which live at rest; and why, on the contrary, it becomes lean in those used to great exercise; its vessels being then rather filled with water than oil; also, why, in lean and hydropic persons, its vessels are distended with a thin serum; and, lastly, we see, that, as the motion is greater, so there is a greater quantity of oil required, and forced towards the splenic branch. We may further observe, that the omentum closely adheres to the viscera, which are almost quite devoid of fat.

With the blood, coming from the omentum, that is mixed which returns from the stomach, by the veins called *Venæ breves*, the left *Gastro-epiploica*, the greater gastric, the right *Gastro-epiploica*, and that from the pylorus; which blood is deprived of the lymph, they discharged into the cavity of the stomach, and is, therefore, also mixed, in several places, with the blood returning from the omentum; yet, perhaps, it may bring along with it a great part of that most

subtle fluid, received from the absorbent vessels of the stomach, made out of the finest portion of the aliment; small branches, likewise, from the pancreas, and the internal hemorrhoid-vein, here deposite their blood, which is, perhaps, a little sharper than the rest.

Lastly, all the blood, which was carried to the mesentery and intestins, by the upper and lower mesenteric arteries, having there performed its office, returns into the mesenteric veins, and is at last mixed with all these humors, before they enter the liver; and this last wants the lymphæ, discharged into the intestins; but, being again furnished with a thin bile, lymphæ, and, perhaps, a part of the chyle, it supplies the liver with matter, not unfit to join with the juice of the spleen, and make bile.

The blood, therefore, which immediately flows, through the *Vena Portæ*, into the liver, is fluid, attenuated, and well impregnated with spirits, a thin lymphæ and bile; and so, partly by the assistance of respiration, which is here strong, and partly by the weaker force of blood pressing on every side, these several humors, squeezed from different parts, are, by that means, well mixed together, in the large cavity of the *Vena Portæ*, where they meet, whence they become fitter to pass through, and secrete in, the veins.

All we shall further say of the action of the omentum, is, that it not only serves to keep the parts of the abdomen warm, moist and slippery, that they may easily move upon one another, without much rubbing or fretting; but that it seems to be, in a great measure, repository of oily parts, to supply the deficiency of such particles or substances in the blood, when wasted or consumed by vehement exercise, want of aliment, or ill digestion. And if the spleen happens to be deficient in performing its office, by attenuating and exalting the sweet, soft, and oily parts of the blood, which supply the liver with proper matter for the preparation of bile; the omentum, being stocked with a sufficient quantity of a subtle, oily substance, may



in some degree make good that deficiency, till its stock be exhausted.



## C H A P. XII.

### *Of the Action and Use of the Liver.*

**T**HE *Vena Porta*, composed of the branches of so many veins, that, joining into a single tube tending upwards, enters the liver, about the middle of its hollow superficies, betwixt the tubercles, or protuberances, called *πύλαι*, gates; and, having presently acquir'd a firm, fibrous coat, like those of an artery, which serves for a sheath, it becomes stronger, and forms a large sinus; into which this compound humor being driven together, collected and retarded, it is, by the proper motion of its concurrence, and the action of respiration, equally mixed and divided into more homogeneous parts.

But then, it soon loses the nature of a vein and sinus, and, being divided into five branches, and afterwards into abundance of less ones, it is distributed to every part of the liver; so that, at length, they every where become invisible, and compose the principal part of the substance of the liver.

Next, the hepatic artery, rising from the left branch of the celiac artery, and entering the liver near the above-mentioned protuberances, inserts it self into the substance of the acquir'd coat of the *Porta*, being distributed through it, divided into the finest capillaries imaginable, and touching every minute part thereof; which it not only does to the coat, but all the other parts; and thus it serves as a coat hereto, although, that standing not in need of so thick an one, it does not intimately penetrate the greater vessels thereof. To these, are added two others from the diaphragm, and the *Ligamentum*

*suspensorium*, their branches being inferted with the former; and, last of all, they are joined by others from the cystic arteries.

The *Vena cava*, tending upwards towards the diaphragm, and insinuating it self into the gibbous part of it, there receives, through distinct perforations, three large branches from the liver, and a great many other less ones; which, being composed of innumerable small twigs, dispersed through the whole substance of the liver, at last bring hither all the blood conveyed to the liver, by the *Vena Portæ*; though these branches seem less, both in number and size, than those of the *Porta*.

Wherever the extremities of these two last mentioned veins, meet, they become so small, that they appear to terminate in a wonderful fine substance, twisted up in bundles; where distinct glands seem to be formed, composed of invisible vessels that separate from one another, much like those which are called simple glands; these, united, form small lobes, which, joined together, make large ones; and, that the substance of the liver is thus composed, appears from observations made on insects, fish, quadrupeds and birds, the growth of the liver in such creatures, and diseases of the part; these observations are also further confirmed by injections and the naked eye.

In all the places mention'd, or about these glands, there appears a small tube, whose rise and origin from the glands, is invisible: this following all the ramifications of the *Porta*, and being covered and involved in the same tegument, adheres so firmly thereto, that it can scarce be separated; and still grows larger and larger, by the addition of other twigs, of the same kind: and, at the last, ends in one great tube, at the trunk of the *Vena Portæ*, called *Porus hepaticus*, or the hepatic duct; wherein is constantly discharged, and receiv'd a humor, very different from blood, term'd hepatic bile.



If we consider the fabric of the *Vena Portæ*, *Cava*, and *Porus hepaticus*, together, with the motion of the humors, forced into the *Vena Portæ*; the nature of the humor in the *Porus biliaris*, or *hepaticus*; and the several anatomical experiments that have been made by ligatures, cutting the vessels, and collecting the bile, it appears very evidently, that a humor, separated in the glands, is conveyed, through the *Porus biliaris*, out of the liver; and, that the blood, brought thither by the *Vena Portæ*, is carried by the *Vena cava*, towards the heart.

And the same is more clearly illustrated, by the distribution of the hepatic nerve, which accompanies this and the *Vena Portæ*, through all its divisions.

In men, the *Vesica fellea*, or gall-bladder, which is of an oval figure, adheres to the cavity of the liver; it is interwoven with innumerable vessels, almost of every kind: 'tis large, and terminates in a crooked canal, all wrinkled on the inside, and like a repository; the neck of it rising narrow and higher than the bottom; being continued it is joined with the *Porus hepaticus*, and meets it at acute angles; when both unite and make a common duct, larger than either of the former. This common duct, descending obliquely, penetrates the external coat of the duodenum, making an acute angle therewith; and, descending betwixt this and the other, it perforates that; but, proceeding betwixt it and the third, for a considerable space, it discharges it self, through a round aperture, into the cavity of the gut; whence it appears, that the bile cannot at all times, and in every case, flow into it from the liver; but, only when the intestines are relaxed, and, by no means, when they are greatly distended.

If we hydrostatically consider the structure of the liver, and compare the result with what hath been already said thereof, it will evidently appear, that a humor is carried into the intestines, from every part of that viscus, as well as from the gall-bladder, by a natural force, in



the place where the chyle, first discharged out of the stomach, is detained; which is manifest, first, because sometimes, when the gall-bladder is wanting, it is supplied by many small receptacles of the bile, formed of excretory bilious tubes united; from whence the bile is conveyed into the duodenum, by a great number of small canals.

We find also, by experiments, that there is an open and ready passage, from the cavity of the gall-bladder, into the liver, the *Porus biliarius*, and intestins; and also, through the liver, from the *Porus hepaticus*, into the gall-bladder, the cystic duct, and the guts; and again out of the hepatic duct, into that of the gall-bladder, and on the contrary. Comparative anatomy hath informed us, that sometimes, in horses, the gall-bladder hath been wanting; that, at others the hepatic duct hath discharged its humor into the bottom of the gall-bladder: we know, likewise, from anatomy, that the hepatic liquor is very different from the bile, contained in the gall-bladder; from whence it appears, that the hepatic liquor naturally tends downwards, and sometimes into the *Vesica fellea*; sometimes it flows back, through the liver, into the *Vena cava*, and all over the body; the hepatic bile, sometimes stagnating in the gall-bladder, acquires the same nature, with that in the bladder; sometimes a bitter substance is formed in the glands, placed in the membrane of the bladder, fed by the cystic arteries, as in the membrane in the cavity of the ears; and lastly, is afterwards mixed with the hepatic humor, flowing back, in the bladder: all which particulars are further confirmed by *Glisson*, *Verheyen*, and *Peralt*, who have discovered small, numerous canals, running from the liver and hepatic duct, inserted into the gall-bladder, and perpetually depositing their humor therein.

From what hath been hitherto said, we may conclude, *First*, that the hepatic artery is very serviceable, contributing to the continuance of life, nourish-

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ment and heat, to force forwards the hepatic humors, as well as to separate and expel them; and therefore it is wonderfully distributed through the most subtile and external membrane of the liver; that lymphatics, which are first invisible, but afterwards become conspicuous, proceed, in great abundance, from every part of the liver, which terminate not in the *Vena Portæ*, but the receptacle of the chyle; that there are veins to receive the superfluous blood from the hepatic artery, and convey it into part of the *Vena azygos*, below the diaphragm; that all the viscera of the abdomen, which assist in chylication, the spleen, omentum, stomach, pancreas, mesentery and intestins, serve the liver, by sending blood thereto, after it has suffered great alterations in those several parts; that veins may be changed into arteries, or vessels like thereto, in fabric size, and use; that secretion may be made from venal blood; that blood, drove from the heart, may be twice venal, and as many times arterial, before it returns to the heart again; that the humors pass through the liver very slowly; and, that, therefore, the situation and connection of the liver, is most commodious under the diaphragm; that, in those who use but little action, slime, stones, worms and other filth may easily be generated about this viscus, and occasion obstructions, and many other distempers; that the spleen is wholly design'd to be serviceable to the liver, in preparing the bile; whence there is so great a resemblance in every circumstance, betwixt both, in respect of health and sickness; that the matter of the bile, as appears by chymical analysis, is different from that of all the other humors; that there is a sort of similitude, betwixt the sinus of the *Vena Portæ*, and that of the heart; betwixt the five branches of it, and the arteries rising from the ventricles of the heart; that there is here a particular manner in the bloods circulation, from what happens in the rest of the body; that there is no greater difficulty to be met with, in curing distempers, than in these belonging to

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to this part; that there is not so great a concurrence of viscera, vessels, humors and causes, to prepare any other fluid in the body, as there is to produce the bile; it follows, that it is the most useful, universal and efficacious medium, in assimilating and changing a foreign humor, into a state proper for the body: bile, therefore, is not an excrement, but a necessary and natural humor, of which there are two sorts; lastly, it appears, that the liver helps to prepare the chyle as well as the blood.

To these observations and conclusions, we may add, that nature hath well provided against any bad accidents, that might befall this part in performing its office; for, *First*, as the substance of the liver is so very tender and soft, the force of arterial pulsation would have been too violent for its texture; besides, there are alterations, previously necessary, to be made in the blood, as it circulates through the vessels hereof. *Secondly*, the coat is encompassed with an artery, whose pulsation must needs compress the branches of the *Porta*, and protrude the blood; now, this motion might, otherwise, have been too slow, and have wanted sufficient force to carry it forwards. *Thirdly*, the pulsation of the hepatic artery, not only protrudes the blood in the *Porta*, but retards the too quick descent of the bile, through the *Ductus biliaris*, contained in the *Vagina Porta*; which, being thus kept back, may prevent the too easy reception of that humor from the glands, before it is sufficiently prepared and digested. *Fourthly*, the branches of the *Vena cava*, being less in number and bulk than those of the *Vena Porta*, prevent the too quick passage of the humor through the glands, by not receiving and admitting them too fast and easily, lest, being crude and digested, they should not be fit for secretion; because too little compressed and ground, by the arterial force, and immediately passing into the *Cava*.



It is necessary, that the blood should not flow too fast through the liver, because time seems requisite to the preparation of the bile; and therefore perhaps the liver, as well as the spleen, acts, in some measure, by a proper and natural fermentation and digestion, as well as attenuation and percolation; so great a change being here wrought in the nature of the humors.

From all that hath been observed, it appears that the liver is the chief instrument of chylification and sanguification; the bile it separates, perfecting the chymus prepared in the stomach, and diluting the chyle further, by its lymphatics in the receptacle of chyle; and that it not only thus early lays the foundation of further improvements in the chyle, but, by communicating its bitter tincture to the blood, helps to preserve and continue its mixture.

Again, it appears to be the chief instrument of sanguification, since all the viscera in the abdomen, are subservient to it, and afford their several ingredients for so grand a preparation, and useful a mixture. It further seems to be a principal agent in sanguification, since, in an *Embryo*, the nourishment, from the maternal blood, is first deposited in the *Vena Porta*, and thereby conveyed to the liver; and, passing through that, into the *Cava*, the first drop is stopped and perceived, being gradually collected in the heart, or *Punctum saliens*, before that is yet able to protrude it forwards.



## C H A P. XIII.

### *Of the Action and Use of the Kidneys.*

**T**H E kidneys have so convenient a situation and connection, that they are assisted by the motion and pressure of the circumjacent parts, to discharge the



the excrements of the viscera; especially the right one, which is most advantageously seated; both being defended by the membrane of the *Peritonæum*, expanded about them, and also by the harder fat, wherein they are included.

They receive the glands that rest on their top, but inclining towards their cavity; from which rule they seldom vary; but seldom have the same form or magnitude in different persons. They are supplied with one or more considerable branches, from the descending trunk of the aorta; and then, having obtain'd another membrane, these are divided into four or five ramifications; and those, again, into abundance of lesser ones; and lastly, into still smaller, which become invisible, and are distributed through all the substance of the kidneys. Those branches of these arteries, being continued in a vermicular form, united at their mutual concussions, and separating again, they seem to form conglomerate glands. From the extremities hereof, small reductory veins seem to arise; as also, small pellucid lateral tubes, which receive the urine separated from the arteries, and carry it off: these, united, form abundance of variously angled, pyramidal bodies, and at last end in about twelve several substances, called *Papillæ*, which are membranous; whereinto a great many mouths of pipes, every where, and on every side, open obliquely, both externally and internally.

The substance of the kidneys, likewise, contains several small, round, hallow bodies, covered with minute vessels on every side, and furnished with veins and nerves, which reach to those pipes that convey the urine, and which seem to occasion most of distempers and concretions that happen here; as appears in the kidneys of a fetus. For this reason, the kidneys seem to perform their office two ways, *viz.* by the larger glands, and the more simple ones of *Ruyfche*; which is not contrary to the custom of nature elsewhere



where, as in the liver: but these last, upon more strict enquiry, seem rather as *Ruysche* imagines, the arteries, twisted and wreathed together, than glands.

The other part, of the renal artery, seems from the blood it contains, to supply necessities for the life, and preservation of the part, and its natural heat, hence the lymph seems to arise, that so plentifully returns from the kidneys; not as an excrement, but, useful and without any taste of urine, and is discharged into the receptacle of chyle. From these glands, doubtless, the veins arise, which carry back the superfluous blood; for the small capillaries, springing from the extremities of the arteries, and collected into greater branches like them, are at last united into stems of an undetermin'd number, that variously empty the blood after it has here perform'd its office, into the *Vena cava*.

The *Papillæ* lay down the urine, brought thereto, into a large cavity, formed by the expanded membrane of the *Pelvis*, furnished with a soft sort of fat; where, being collected, retarded and mixed together it is drove further into the ureter, which is formed of the pelvis, made narrower; and from thence it is discharged into the bladder; for eleven or twelve membranous canals, rising from the outside of the *Papillæ*, receive them and the liquor, flowing from them, and pass into three great branches, which, uniting again into one, form the large *Pelvis*, that terminates in a thick and strong membranous tube, furnished with veins, arteries, nerves, lymphatic vessels, musculous fibres, and mucilaginous vessels, to soften and render the sides slippery. This vessel is called an ureter; which first running straight downwards, is soon bent inwards, and then perpetually runs under the duplicature of the peritoneum, at an unequal distance in different places, till it be inserted into the back part of the bladder, about two fingers breadth from the neck of it; and the two about as far distant from one another: and, having penetrated the external coat, they run down-



downwards, about the little fingers breadth, obliquely, betwixt this and the other, and then penetrate into the cavity of the bladder; afterwards descending in a cylindrical form, and their fibres being produced, they compose a long, round body, that, when the bladder is full, hinders the urine from flowing back into the ureters, which, the bladder being then distended, are, by means of this body depressed, blocked up, and so safely discharge the urine therein; and, by their fabric, hinder it from being any way pressed back into them; all which is evidently proved, by microscopes, injections, ligatures, comparative anatomy, opening the dead bodies of those that were subject to distempers in this part, and by monstrous kidneys.

As for the secretion of urine, that is promoted by the force of the heart, and the strength of the arteries, by which the watry part of the blood is drove and forced thro' innumerable turnings, and windings of the vessels; and attenuated by resistances, opposite motions, violent concussions, and various mixtures, till, at last, the more liquid part thereof is forced through canals, somewhat smaller than blood-vessels, and so collected and discharged.

In this operation, the very learned *Boerhaave* supposes no attractive, emulsive, or the like quality to be necessary; no more, says he, is a fermentation, there being here no room for it, no evident cause, nor any time, or matter, allowed for its mixture and effects: he adds, for the same reasons, there resides no precipitating quality in this part, to occasion an extraordinary discharge; no *Helmontian* liquid dung, or *Scoriæ* mixed, as a preservative against the stone; nor, lastly, any secret effect; for that all the humors, which are thinner than urine, will be discharged this way, if they are pressed into these vessels: But from hence, says he, we must understand, there is a reason why they do not flow to those vessels; or why, if they do, great and sudden weakness ensues. Now granting, that the grossness of the humor

will



will here obstruct their separation ; 'tis certain, that such things as attenuate gross humors, and render them thin and fluid, must be effectual in promoting the natural action and discharge of this part : and whether a fermentation, when that word is properly understood, may not forward this action, I leave those who are acquainted with the nature thereof, and with its actual existence in the human body, and its necessity to induce a perfect alteration of substance therein, to determine.

But the glands, called *Renes succenturiati*, which are placed above the kidneys, though separated with interposed fat, being near the diaphragm, and united by sanguiferous vessels, and compressed betwixt that and the kidneys ; being furnished with arteries, and having no proper excretory vessel, yet appearing of a like structure with the kidneys, and to have the same concomitant accidents with the spleen ; discharging also all their blood, by proper vessels, into the emulgent veins, may, very probably, perform their office upon the venal blood ; which hath lost its most liquid part, and its dissolving salt, by the separation of urine, as the splenic blood prepares and disposes that conveyed to the liver, to separate and afford the bile.

But not only the *Renes succenturiati* supply the blood, with a fresh, lixivate salt, to attenuate the humors, and recruit the stock of what was grown less serviceable in the mass of blood, and only fit to be separated as excrementitious ; but even the nitrous salt, imbibed into the blood, thro' the pores of the lungs, in respiration, or otherwise, may, doubtless, dispose the serum, as well as the grosser excrementitious salts to be separated and discharged by urine ; for we find, by experience, that nitrous salts, taken inwardly, have that diuretic effect : nor will there ever be any deficiency, but a continual separation of urine, if the primary cause, in respect of the kidneys and ureters, be in a natural state, and not obstructed by accidents ; as their own collapsion, or concretions,

which



which may obstruct the passage, either by blocking up the small vessels, or the large ones by compressure.

The *Glandulae succenturiatæ* seem not only serviceable in supplying the blood, with a fresh lixiviate salt, which may help to cleanse it of its feces, and dispose them to go off by urine; but also, this lixivium, swimming in the blood, and uniting with the nitrous salt thereof, helps to compose that common salt, which is so absolutely necessary to preserve it from putrefaction; so that nature here seems provided with a salt spring within herself, which may constantly afford what is necessary to her preservation, and to make good the daily expence of that drank up by phlegm, or cast off as excrementitious sweat and urine.

Farther, these glands are not only useful, as they thus afford the blood a constant, additional quantity of salt, to prevent putrefaction; (for the mass of blood constantly swims in pickle, to preserve it) but this salt, also, serves to fret away, and cleanse the blood of its grosser slime, that is unfit for nourishment; and which, being discharged by urine, when dissolved and separated in the kidneys, produces that cloud or sediment that appears in urine, after it is voided and comes to be cold.

This salt, moreover, thus prepared by these glands, seems a very necessary ingredient in making the bile, which contains saline as well as oily parts: so that they are not only assistant to nature, in supplying the loss of what goes off by urine, and help the kidneys to discharge what is excrementitious; but they may, likewise, be esteemed as one of those useful viscera, that assist the liver and the whole mass of blood, by supplying every part with a moderate quantity of salt, to preserve the humor therein prepared.

And, as these salts constantly swim in the blood, and tend to preserve it from putrefaction, as well as supply each part with such a necessary ingredient; so the serum of the blood, in which they are dissolved,

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communicates its wholesome tincture to all the parts through which it circulates, and every humor separated therefrom. Hence it appears, that the *Glandulae succenturiatæ* are, though a small part, of very great use: and even their situation seems to shew their office; for, by lying on each side of the kidneys, they are ready to supply what is there, otherwise, too plentifully thrown off and discharged.

## C H A P. XIV.

*Concerning the Action and Use of the Bladder of Urine.*

**I**N the lower region of the abdomen, under the super-expanded coat of the *Peritonæum*, lies the bladder, consisting of three distinct membranes, *viz.* the external one, from the peritoneum, the middle one, consisting of different, muscular fibres, and the inward one, furnished with mucilaginous glands, to defend the part from the acrimony of the urine. A great many vessels, distributed through this part, have a peculiar course, different from those which are observed in other parts. When the urine, either by its acrimony, quantity, or long detention, begins to fret and corrode, distend or twinge the part, it occasions an uneasy sensation; and having worn off the slime, the musculous coat of the bladder contracts; whereupon the sphincter is relaxed; and all the parts, contained in the abdomen, pressing upon the bladder, the urine is forced down upon the sphincter muscle, at the neck thereof, and distends it; being placed in the upper part of the neck of the bladder, above the *Prostata*, with its transverse fibres, not very thick, under the external right fibres; so that the urine is thrown by the same force, into the cavity of the *Urethra*; which is lined with a fat, soft, and slippery juice, to defend it from the acrimony of the urine; and supplied with vessels

L observed

observed by *Cowper* and *Morgagni*, in men; and descending in a very winding course, often rising with a great variety; the passage being full of cavities and spongy: and while the urethra is flaccid, the urine is discharged through it, clear out of the body.

As soon as this action ceases, the fibres of the sphincter muscles, being no longer pressed upon, contract themselves of their own accord, and close up the bladder; and then the muscles in men, which act in pressing out the urine, squeeze out the remaining part thereof; for, since these rise out of the upper, and external part of the *Urethra*, under the *Os Pubis*, there their tendons parting from one another, sink under the *Corpora cavernosa Penis*, and encompass part of the urethra; where going out of the bladder very broad, and encompassed with their proper cavernous body, and not as yet externally united with the *Corpora cavernosa Penis*, but on the lower side, and so proceeding to the *Peritoneum*, they seem to grow tendinous, and perhaps adhere, in a manner, together, at least with the transverse muscles of the *Penis*; and to be fixed at the root of the *Urethra*. Their action is easily understood; but being lost in old men, they find a troublesome dripping after making water, and a sharp corroding pain, while the urine remains there in its passage.

As for the nature of the urine, it is so different, that, it must first be distinguished, before the nature of it can be discovered: for, by plentifully drinking watrish liquor, it is crude, much in quantity, lenient, insipid, without much scent, watry, and easily retained in the bladder: But, that which is discharged after the chyle, is new made, appears more digested, less in quantity, sharper and salt, smells stronger, and is not so easily kept in.

The urine, when detained a moderate time in the body, is of a yellow color, and a sharp briny taste; it rises in bubbles upon being shook together, and is sometimes applied with good success, to scirrous tumors; whilst exposed to the air to cool, abundance of stringy particles condense together therein, and adhere



adhere to the sides of the containing vessel; or else according to their specific gravity, or the quantity of air included in them, are suspended or rise to the top. Whilst fresh and warm, it gives a red color to a tincture of mallow flowers, but when cold a green one; it also precipitates a solution of *Saccharum Saturni*, and corrosive sublimate; when distilled, it affords a large quantity of a thin watery fluid, which is presently after impregnated with alkaline salts. The remaining thick substance exposed to a greater heat, yields a dusky, thick spirit, which is sharp, and greatly abounds in volatile salt; some of which will also adhere to the sides of the receiver: a small quantity of thick fetid oil now remains, which appears, upon trial, of an alkaline nature. Lastly, the *Caput mortuum* diluted, affords a muriatic salt. Urine, therefore, appears to consist of abundance of serum, a few volatile acid, but with many volatile alkalious parts, some muriatic, and some sulphureous, and a small number of earthy ones, intimately mixed and ground together; the stringy particles, seeming not properly to belong to it; but rather to be fibrous parts of the blood, carried off by the motion thereof. The proper proportions of these parts, cannot be ascertained; not only upon account of that general difficulty in obtaining every one of them intire, pure, and unmixed with the others; but by reason of the differences herein observed in different subjects, sexes, ages, manner of life, and the nature of the aliment made use of.

That which is discharged, when the chyle is just turned into serum, is redder, more digested, much less in quantity, and more salt, fetid and sharp, much more stimulating, and consequently cannot be held so long. But that made after long fasting, where the humors have been much ground, and fretted together, and the solid parts deterged, is least in quantity, very sharp, fetid and red, hard to be retained, and almost putrefied.

From hence it appears, why after great heat, motion, sweat, or abstinence from drink, different urine



must be voided, and *Vice versa*; and why the urine is thinner, sharper, more fetid, and saltier than the blood.

From hence, it likewise appears of what use, salt, and the *Glandulæ succenturiatæ* are of; and why urine is excrementitious; for the salt supplied by those glands, not only serves to preserve the blood from putrefaction as we said before and helps to digest, fret away crudities, and purge the blood of its phlegm; but when by repeated circulation, it becomes too corrosive, it attenuates those crudities, and becoming thin, as well as pernicious, 'tis discharged with the urine; a fresh stock of salt being again supplied by those glands.

The urine then contains, not only the watry part of the blood, but the sharpest salt; which is most subtle and volatile, and nearly of an alkaline nature; also a thin terrene part, that is ground, fretted, and rendered exceeding volatile. In the watry part, there is also a fetid substance contained, and a viscid oil, so attenuated, that it easily mixes with water, and is hardly separable therefrom; which may therefore in some measure be called a spirit.

The natural salt of urine, is of a lixivate, soapy disposition, and much like sal-ammoniac; yet in some respects different therefrom: it also contains a fixed salt, of the nature of sea salt; being composed of a lixivate one, and a nitrous; of which nature is that which swims in the blood; the nitrous parts being imbibed into it through the lungs, in inspiration: so that the salt in the urine, is neither acid, alkali, ammoniac, nor briny, but of a peculiar disposition.

The oily parts in the urine, proceed from the fat attenuated by attrition; it appears to be simple, and of a peculiar kind different from all others: though by reason of the salt and earth, mixed therewith, it seems at first of a various nature. The earthy part is so thin, and intermixed with the rest, that it does not in the least appear; but being separated from them, is simple, without smell, insipid, white, indissolvable, and fixed.

Neither



Neither well digested serum, nor nutritious juices, true chyle or milk, are ever in the urine; because they are too thick to pass naturally through the small anfractuous winding passages of the kidneys; except when those glands are too much relaxed as in a diabetes.

So that in health, there is never any thing voided by urine thicker than blood, serum or chyle; wherefore aqueous and saline liquors, especially if drank cold, are diuretic; and fermented liquors, but little so; and the less, as they are unctuous; though sharp and thin wines quickly pass off by urine.

From hence we may understand, why urine is made in greater or less quantities; whence proceed the color, smell, taste, thickness, and contents thereof; what swims upon it or sinks therein; for urine differs, according to the different quantities of water, spirit, oil, salt, or earthy parts mixed with it, and according to the different degrees of attrition, it has undergone; which shews the degrees of its digestion, as is most excellently illustrated by *Phosphorus*.

Hence it will likewise appear, why a person, upon violent motion, often makes bloody urine, without any fault of the kidneys, or any suspicion of a stone to occasion it. It appears likewise, how far the separation of urine is necessary to preserve health, or whether it may be supplied by other discharges; and lastly, what use it is of.

Since then, the motion of the humors, the fabric of the body, ligatures, injections, as well as ocular demonstration, and distempers proceeding from a suppression of urine, plainly teach us that this excrement can only be conveniently discharged this way, there is no occasion to feign passages in the stomach and intestines, that throw a humor out of their cavities, into that of the peritoneum; nor in the membrane expanded over the pelvis, and surrounding the bladder, and every where in the substance hereof, pores to lead out of the cavity of the peritoneum, directly into that of the bladder; and that there is no-



thing to resist this motion, but that the passage is quick and easy. There is no occasion to feign such phenomena, or chymical conveniencies, since there appears nothing to produce such things, nor any arguments to prove them.

But, to put this matter beyond question, we may have recourse to experiment. If, therefore, you cut along the *Linea alba*, on the abdomen of a dog, and carefully tie up both the emulgent arteries; squeezing the contents out of the kidneys, ureters, and bladder of urine; then sewing up the wound, and also strictly tying the end of the penis, to prevent any discharge of urine thereat; the dog will continue alive for many hours, and lap water plentifully; but dying at length, when the wound is opened, the stomach will be found full of water, and not a drop of urine in the kidneys, ureters, or bladder. This, then, is an evident demonstration, that all the urine is, in a dog, conveyed along with the blood, by the emulgent arteries, into the kidneys; and consequently there are no particular ducts, from the stomach or elsewhere, to carry it thereto. On the other hand it is demonstrable, that the passages we assign it are abundantly sufficient, to account for the usual quick motion of thin wine, or diuretic liquors, into the bladder.

From hence also it may appear, how little, or how far, the kidneys are concerned with, or contribute to make the seed, and what effect they really have therein. Indeed, the situation of the emulgent and spermatic vessels, of the sphincter muscle, and of the *Glandula prostatica*, shew some latent sympathy, which cannot easily be accounted for, without considering the consent of the parts; the pain of the sphincter muscle affecting the *Glandula prostatica*, by consent of the nerves; and on the contrary.

From what hath been said, likewise, it may appear, why sand, gravel, or stones, are frequently bred out of the contents of the urine.



## C H A P. XV.

*Of the Action of the Muscles.*

**H**A V I N G considered what is transacted in the blood, driven through the viscera, we must enquire into that which is drove into the muscles throughout all the body ; and, lastly, into that which is moved into the external teguments of the body, or which include the internal cavity thereof.

But there being scarce any greater difficulty and obscurity, than in the most minute vessels and instruments of the body ; this hath occasioned a great variety in opinions, and as great a difficulty in chusing the best. However, the solid parts of a human body are either moved by the agitation of the humors, which flow forcibly thro' them, or by the help of the muscles, which are fixed to the parts that are moved ; which being dilacerated, cut asunder, or corrupted, the motion ceases ; and this motion is either voluntary, involuntary, or mixed.

The muscles are said to act, when, becoming shorter, they draw the solids, whereto they are fixed, nearer to one another ; or press them together, and drive the humors out by means thereof. All the difficulty therefore, in this case, is to assign the fabric, and contracting cause, of a muscle ; one of which must certainly have a great dependance upon the other.

Every simple muscle, hitherto known, consists only of one carnous belly, and one tendon ; and may be again divided into others perfectly like the whole, but always less ; and these also, which are compounded of the other, may be divided into still less, but ever a like to the greater ; and, indeed, this division proceeds so far, that at last they become so incredibly small, as to exceed all the power of imagination : But reason will shew us, there must be an end. Since



then, the last is like the whole muscle, it must needs have its belly and tendon, equally with the greater; and may be called a muscular fibre; and of a number of these united, a muscle may properly be said to consist. It appears, therefore, that these fibres are neither of an arterial, venal, or lymphatic kind, but of a different nature; being organs much less than those, and no doubt but vascular, since not composed of one single tract.

Since then it is supposed, that nerves are inserted into every muscle, along with its arteries and veins; and that, there depositing their external coat, they are distributed through the whole body of a muscle; so that no part can be assigned wherein branches hereof are not to be found; and again, that all the nerves there terminate and disappear; and, lastly, that, in other parts of the body, the extremities of the nerves make up, as it were, certain expanded membranes; we conclude, that, respect being had to the nature of the smallest nerves, these fibres are a fine expansion of the extremities of the nerves, having lost their coats, which is hollow within, of the figure of the muscle, and full of spirits, supplied from the cerebrum or cerebellum, by the constant force of the heart.

These fibres united make up bundles, which have another particular membrane, wherein they are inclosed, and kept distinct and separate from the rest; which holds good as far as the senses are able to trace them. This membrane is very thin, and full of cells or cavities, filled with an oily substance; which, being collected and amassed, whilst the parts are at rest, is spent in their motion, and serves to defend, guard, and lubricate the fibres; and is supplied by the arteries, as appears by the injection of quicksilver.

But an artery is also distributed through every muscle; being of such a magnitude, circumference and contexture, that, without care, one would judge the whole body of a muscle to be composed of that alone; these are chiefly distributed amongst the *Fasciculi* of fibres,



fibres, the membranes that enclose them, and the external superficies of every fibre ; where they terminate in net-work plexus's, or folds, oily secretory vessels, minute lymphatics ; and perhaps into hollow fibres, like nerves ; which fibres may also end either in the hollow, muscular, nervous fibres, or constitute the like vessels themselves.

At least, it is evident, that every branch of an artery, in a muscle, hath a vein to answer it ; which, united to another, composes a larger, whereof the sanguiferous vessels of a muscle, and the lymphatic, are formed.

But the tendon of a muscle, strictly examined, is divided into as many fibres as the muscle it self, after such a manner, that the cavity of a muscular fibre, becoming small from its obtuse angle, and growing together into one acute body, becomes stronger, harder, drier, narrower, and almost destitute of sensible vessels ; though, according to *Ruyfche*, innumerable, small, distinct canals appear through all the inmost recesses of a tendon : by the close union of these the whole tendon is formed ; and this may properly be called *Aponeurosis*, or a conjunction like thereto, though used upon another occasion. Of two such muscles, joined in opposite directions, almost all the greater muscles are composed.

The red color, of every muscle, proceeds from the blood, which being washed out, leaves it pale ; but its bulk chiefly proceeds from the arteries, veins, oily vessels, and lymphatics, filled with their proper humors ; for which reason, it is so greatly diminished by old age, leanness, a consumption, long continued boiling, or washing with much compression ; yet in old age, leanness, or a consumption, the motion remains ; and that this may be performed, in muscles that are not red, appears from insects, in which there is no visible red flesh.

The fibres, the *Fasciculi*, the arteries, the nerve, both in living and dead creatures, may be drawn asunder without breaking ; and, however they be stretched



stretched, they retain a power of contracting themselves; but, being cut asunder, the ends fly back from each other, when they become much shorter, decrease in bulk, and contract into a sort of undulating superficies, pressing out their proper Juices. Hence, therefore, they are always in a violent state, in respect of themselves; always kept stretched, whilst they endeavour to contract themselves, but more so in live bodies, than in dead ones; and therefore, an antagonist muscle is necessary, to keep the parts in a due tonic stricture and position.

If the brain be violently compressed, contused, obstructed by a perfect suppuration, or cut out, so that the effect may extend to the medullary part thereof, the action of all the muscles in the body ceases at once, together with all the senses and memory; but the spontaneous motion continues, both in the heart, thorax, vessels, viscera, and vital parts.

If the same happen in the *Cerebellum*, the action of the heart and respiration ceases, together with voluntary motion, and all the senses and life it self is at an end; altho' a vermicular motion in the stomach remains a long while, and may be restored again, the cause being removed; and then the same phenomena happen, as just mentioned about the brain.

If the nerve of a muscle be compressed, tied up, or cut asunder, all motion, vital and voluntary, is quite abolished in that muscle; and if the trunk of a nerve suffer the same, whose branches serve different muscles, the like happens to all of them; but this being loosen'd from its compressure, every thing is as it was. The like being done to any part of the spinal marrow, the action of all the muscles is lost, whose nerves rise below the part affected. And if the same experiment be made in an artery, distributed to one or more muscles, all the same phenomena happen.

The tendon of a muscle in action, is scarce sensibly alter'd, though the flesh is shorten'd, grows hard, pale, swells and bulges outwards, and the tendons draw one towards another; the part fixed to the tendon,



don, is drawn towards that end connected to it that is least susceptible of motion; this action of a muscle is called its contraction, which is much greater and stronger, than the other native contraction above-mentioned; being not natural but acquir'd, whilst the motion of the antagonist is lost. The tendon of a muscle out of action does the same; but the flesh becomes longer, softer, red, sunk, and flatter; this state is called the restoration of a muscle, though it be, in some measure, obtained by the force of the antagonist muscle; for that being perfectly flaccid and unactive, the contraction of the other will continue of its own accord; when, being not reduced to an equilibrium, it will have a prevalent force.

One antagonist acting, while the other remains unactive, the member, whereto they are fixed, is bent; but if both act, it is held steady and immoveable; if neither acts, it is slack and indifferent to motion, or rest, but moveable by that which in the least exceeds the other, whether by addition or subtraction. And these changes happen successively, and by turns, in a moment, or in the least point of time, in the whole flesh throughout the muscle, and so reciprocally are present and absent, without leaving any signs of alteration behind them.

Warm water, being injected into the artery of a muscle that is at rest, or dead, it renews its contraction, though this be done long after the death of the person. The bulk of a contracted muscle, appears rather greater, than less, in all manner of experiments.

The limbs being bent by an external force, though against the will, the flexor muscle puts on the state of contraction, as if it acted by its own proper motion, though, in this case, it is not so strong. The will remaining undetermin'd, all the voluntary muscles are equally full in every vessel, and move by means of the blood and spirits, that are equally dispersed thro' them; and that over all the body at once.

Now, from these phenomena, well considered, the latent

latent properties of the cause of motion in a muscle, plainly appears; as, 1. That it has a power to be present or absent: 2. And consequently to enter into, and go out of, a muscle. 3. That it enters in from some part without, and again returns without: 4. And that too in a moment, at the pleasure of the will. 5. In the very moment, that a muscle is contracted, the fibres thereof are, from within, pressed outwards, towards every point of its superficies, in opposite directions; 6. That is, it must be equally distributed at once, through all the fleshy part of the muscle: 7. And so to dilate the membranes of the fibres, fill, and change them, from an oblong figure to a round one, and thereby to encrease their lesser diameter, diminish their greater, and bring the tendons nearer together. 8. This cause must needs proceed from the cerebrum, the cerebellum, and the origin of the nerves; and is able to overcome those obstacles, which here strongly resist it. 9. To conclude, therefore, a very fluid and thin body, that is in a quick motion, must be forcibly thrust into the muscle.

Now, these requisite qualifications are to be found in the nervous liquor, and in no other of the whole body, according to the judicious *Boerhaave*; and therefore, says he, this is to be taken for the true cause of muscular motion; nor is it difficult, he adds, from hence to understand the manner of its action.

But let it proceed from what cause soever, the spirits will sooner flow from the first origin of one nerve, than through the rest, and be more freely discharged into the fibre open to this nerve; and therefore will be more dilated, at that time lose its elasticity, and suffer and act as we before observed; all which, the same cause remaining, will appear still more evidently, and so the muscle will soon be perfectly swelled, and continue contracted as long as the same determination remains; and, whilst this happens, the whole muscle must afford the same phenomena, as to appearance, in an infinite number of fibres at once. It therefore follows,



follows, that this celerity, being increased in one nerve, by that means, will be the less pressed, which being relaxed, the excess of force being so much the greater, must act the stronger in the muscle contracted.

For which two reasons, all the fibres of a muscle, pressing with great force, will streighten the intervals that lie betwixt them, and the blood-vessels placed therein; upon which, the veins will be emptied, and the compressed arteries repel the grosser, that is, the red part of the blood; but the most subtle, by the force of the heart, and their own, will be drove into the smallest fibres; and thus, the blood being drove out, we may conceive the whole body of the muscle to act by virtue of a subtle fluid, brought thither by the concurring nerves and arteries, which perfectly accounts for the phenomena; for that part will be attracted which is fixed to the tendon drawn, provided it makes ever so little less resistance, than the force that acts upon it.

But this cause ceasing, the elasticity of the fibres, the balanced force of the rest, and the circumjacent parts, forced beyond their tone, by that contracted muscle, at once restore a perfect equilibrium in all the parts. Every appearance, therefore, is thus satisfied by understanding the fabric, and cause which is actually here present in the body: but the power of increasing celerity, in the origin of the nerves, is postulated as a thing common to all hypotheses, nor can this be farther explained.

The incorporeal faculty of *Galen*, influencing the muscles, will here be of no service, no more than the nitrous spirit of the nerves, mixed with the oil of the blood, and so kindled and rarified; much less will the acid spirit of the nerves, with the alkalies of the blood; nor the ebullition of ether, and arterial juice; nor the attractive power, betwixt the most minute parts of the humors here increased or diminished, help us in this matter: for these are repugnant to sense, the organs applied, the matter made use of, the mixture, proportion, duration, and greatness of the phenomena; nor is there the least occasion for them.

But



But that equable influx, happening at once into all the muscles of the whole body, cannot at the same time flow into the heart, when contracted, but is collected in the nerves thereof; whence it is supplied, to the cavities, by the auricles, the *Vena cava*, and the pulmonary vein; into its substance, by the coronary arteries; and into the musculous fibres, by the nerves; being then violently contracted in a moment; but presently, the venal blood being plentifully and forcibly discharged into the auricles, and venous sinus's; by violently distending their sides, it compresses the cardiac nerves, distributed near them; whilst those cardiac nerves, which lying near the *Aorta*, and the pulmonary artery, tend to the heart; and at the same time, that these are distended by repletion, they are also compressed; and therefore the heart, deprived of spirits, becomes paralytic; and, being relaxed, is again filled; whereby all the cardiac nerves, being free again, they at once contract the heart; and thus alternately that part always acts, and ceases to act. Of the reciprocal motion of the muscles serving to respiration, we shall speak hereafter.

But how great this muscular force is, he only understands, who knows, 1. The place where the tendon, that draws, is inserted to the part that is to be moved, with regard to the distance from the immovable center, about which the flexure of the part is made. 2. The obliquity of direction, through the determined angles, which are here, for the most part, very acute. 3. The weight of the part to be moved. 4. The weight of the body hanging to it, and of that to be lifted; and the place, in which it is applied. And, 5. the duplication of the sum of this force which is required, to make a traction towards a fixed termination; all which *Borelli* hath excellently demonstrated from mechanic rules.

But how a nerve can give so great a force to a muscle, hydraulics and hydrostatics can best inform us.

Now, this force of a muscle is directed by wonderful mechanical contrivances; as, 1. Membranous bandages



bandages broadly expanded, encompassing the muscles and tendons underneath, and binding them together, as at the wrists and ankles. 2. Broad muscular bandages, as in the arm, back and thighs. 3. By cartilaginous pulleys, as in the corner of the eye; or of a bony nature, as in the pterygostaphyline muscles. 4. By one muscle passing, and directing another's motion, as in the *Musculi styloceratomyoidei*. 5. By props and supports sustaining, elevating, and directing the tendons of the muscles, as in the *Papilla* of the knee, and the bones called *Sesamoidea*, about the joints of the fingers. 6. By appendices joined to bones, as the trochanters in those of the thigh. 7. By the muscles themselves encompassing the bones, as the muscle called *Marsupialis*, or *Obturator internus*. 8. By fat and mucilaginous cases slackly embracing the muscles, especially the tendons, and, in a wonderful manner, procuring an expeditious motion.

But the attractive power of the muscles, is chiefly promoted by compound muscles, which are made of a great many joined together; which, being all united by tendons into one, have the greater force, as in the *Deltoides*, and pectoral muscles, the *Biceps* of the *Os humeri*, and the *Triceps* of the thigh; for the more numerous the fibres, the stronger the muscles; and the longer the fibres, the more are they disposed for bending: moreover, the small transverse fibres, strengthening, confining and retaining them, in their due place and situation, add much to the constancy of their motion and strength.

The action of every single muscle is easily known, if its connection and tendency, and the comparative aptitude for motion in each part, to which the tendons are fixed, be understood. The muscles, therefore, which serve for voluntary motion, have nerves that rise last from the *Cerebrum*; but those which serve for involuntary motion, and vital functions, receive their nerves from the *Cerebellum*.

The motion remaining in the fibres after death, depends



depends upon their voluntary contraction, and that of the vessels ; nor does the contraction of a muscle, by any means, proceed from involuntary contraction, or the contraction of a nerve.

Though the nervous juice hath a violent action upon a muscle, yet it hurts not the vessels it passes through, as appears in hydraulic engines. A muscle kept in violent motion too long, grows painful, inflames and mortifies ; but, when successively contracted and relaxed, the blood is reciprocally received and pressed out with violence ; by which means it is attenuated and dissolved by attrition, as in the lungs and other parts.

From hence we may judge, why a life spent in agility and exercise, hath different effects from a sedentary one. By too much rest, the oily parts, collected, in a sound body, streighten the vessels and fibres, and almost compress them together ; and a creature that uses too much exercise grows lean. Old age, and a laborious life, almost changes the muscles into tendons ; and, after, the tendons into cartilages and bones.

From the doctrine delivered about the action of a muscle, it appears, in great measure, what may be the cause of the contraction which produces motion ; but though the learned *Boerhaavi* is here, as every where else, very curious and accurate in his observation, which occasions me to make use of his collection ; yet, on this head, there seems to be something further to be considered and deduced, from those instructive remarks he has given us.

And, *first*, though the nerves are inserted into the muscular fibres, it does not follow, that those fibres act like nerves : and, if the contraction of them may be prevented, by a ligature upon the artery, as well as upon the nerve, it must follow, that the arterial blood is jointly concerned in producing that action ; and that the motion of the parts is not to be attributed to the effects of the nervous juice only, but also to the concurrent assistance of the arterial blood, or something



thing separated therefrom. And since our author says, a very fluid, thin body, in a quick motion, is here to be pressed with force into the muscle; the arterial blood seems as likely to do service as the spirits; that being pressed with greater violence thro' the arteries, by the contraction of the heart, than they thro' the nerves, by their own bare protrusion; the brain, at least, not propelling them forcibly; though, when fermented with the arterial blood, they may add to its subtilty, as it adds to their force, and so jointly produce very great effects; and such we see in the viscera; for the spirits are absolutely necessary, to compleat the action of every part.

He allows, indeed, that the arterial blood is, in a small quantity, pressed into the muscles; and, at the same time, supposes the larger vessels to be stopped and obstructed; but it seems strange, that a small force should make its way where a greater is resisted; and, consequently, that the nervous juice, pressed in with a gentle motion from the brain, should overpower and obstruct the violent pressure of the heart; but that the arterial blood is not so easily obstructed, appears from the common observations in phlebotomy; where, notwithstanding the reflux of the blood, when its progress is stopped by ligature, there is a sufficient supply through the muscles, though contracted by griping, to afford a very great discharge.

What weight *Steno's* experiment may have, I will not pretend to determine; but it would be unfair here, to pass over in silence an experiment which seems to lessen the force of it. *Steno*, we know, upon tying up the descending trunk of the aorta, of a live dog, found the motion of all the hinder parts below the kidneys, to cease; which constantly returned again upon loosing the ligature; hence it was pretty universally believed, that muscular motion depended upon the blood. The learned Monsieur *Astruc*, however, having frequently repeated this experiment, and sometimes in a different manner from *Steno*, observed, that not only motion, but the sense of feeling was also, by this means, lost in the parts

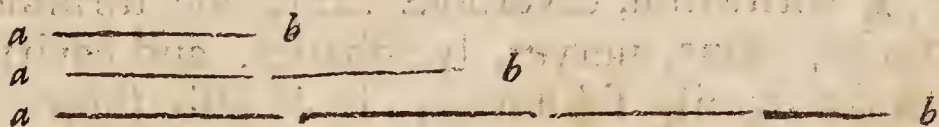


above-mentioned ; so that neither needles, knives, or burning coals, could force any indications of pain from the dogs whereon he made the experiment. From whence it appears, that the flux of animal spirits was hereby obstructed, as well as the blood from the heart. *Steno's* experiment, therefore, seemed to *Monfieur Astruc* inconclusive ; since the animal spirits might still be the only cause of muscular motion. But, wondering at this odd phenomenon, he at length conjectured, that the ligature prevented the influx of blood into the *Arteriæ sacrae*, and *Lumbares*, which send out branches to the spinal marrow ; and, by this means, prevented the pulsation requisite to convey the spirits into the crural and ischiadic nerves ; he, therefore, tied up, not the aorta, but the two iliac and the intermediate, hypogastric arteries, below the twofold branching of the aorta ; upon which the dog remained well, and both sense and motion continued in his hinder parts, though they received not one drop of blood : and as to the spinal marrow, it continued as in a natural state. The same author farther observes, that the like phenomenon happens, upon tying up the crural arteries ; for altho' the *Glutai*, and other muscles on the hind part of the leg, are not entirely deprived of blood thereby, yet some muscles are ; which nevertheless perform their natural actions. These experiments are so remarkable, that I durst not here omit them ; but, as to the certainty of them, and the consequences that may hence be drawn, I leave every one to try and judge for themselves. To return,

As for the velocity, in this case, it is very probable, that the blood moves much quicker through the arteries, than the spirits through the nerves ; the first being drove by the violent contraction of the heart, and the latter chiefly protruded and thrust forwards by fresh spirits, separated by the cortical part of the brain ; though, at the extremities of the vessels, the fermentation is much stronger, and secretion more copious, as a greater influx of spirits occasions a more violent attrition ; so that, as the spirits are determi-  
ned



ned by the will, in greater quantities into a muscle, a greater quantity of fluid may press into, and distend the muscular fibres. But the blood it self is always in a brisk motion, by the constant pressure of the heart; and how, the will determining a greater quantity of spirits to any muscle, they come to have an immediate effect, in that part, may be easily explained; for the operation is as suddenly performed, supposing the part ever so far distant, as if it were ever so near. To explain which, we may consider, that, if one muscle be at the toe, another in the eye, and a third in the thigh; since the will actually hath the power to determine spirits, in greater or less quantities, to each, the nerves, that respectively lead to those several parts, being before full of spirits, at the same time that an impression is made upon the origin of the nerves, according to the quantity pressed in, there will, by the communication of motion, be as much squeezed out at the other end, let the vessel be long or short; the contiguity of the parts, continuing the pressure to the extremities at ever so great a distance, in the same time, as it would at a small one; the pressure being only discontinued, where the contiguity is discontinued; for suppose a pressure be made, upon the three lines of different lengths,  $a, a, a$ , whose extremities are  $b, b, b$ , when the force is exerted upon the points  $a, a, a$ , the extremities  $b, b, b$ , will move together,



the contiguity reaching through all the length of each line; and supposing these lines to be nerves; at the same time that spirits are forced into  $a, a, a$ , the orifices, the same quantity is thrust out at  $b, b, b$ , the extremities. Thus the pulse may be felt at the toe, as soon as at the breast; whence the celerity of motion does not depend upon the velocity of the spirits, through the nerves, so much as upon the celerity of the determination, which quickens the



protrusions; at the same time, therefore, that the will determines spirits into the origin of the nerves, the protrusion continued, presses them out of the extremities, which, joined with the arterial blood, soon perform their office.

How the will determines the protrusive motion of the spirits, is too difficult a subject to be here inquired into. Nor is it, perhaps, much less difficult, to demonstrate, by mathematic rules, the real manner how the action of a muscle is performed; though some have undertook it; for, as the finest vessels are too small for us to discover their contexture and fabric; and as we cannot, therefore, be mathematically certain of their positions and frame; so we cannot, by such rules, draw any conclusions amounting to mathematical certainty: whatever is too fine and minute, to be an object of sense, can only be a subject of reason; and since this is of that kind, it is too long for this place. And if we would indulge conjectures, it requires a particular tract, wherein there may be scope allowed to our reason.

## C H A P. XVI.

*Of the Office and Use of the Skin, together with the Separation of the Sweat.*

**A**LL the muscles, under the skin, are covered with a thin, cavernous membrane; furnished with arteries, veins, nerves, lymphatics, and cavities that contain an oily substance; it is also supplied with musculous fibres, distributed throughout its substance, to strengthen its structure, and promote the expression of that oil. It is very apt to dilate, stretch, and increase to any dimensions; and chiefly collects fat, which stagnates in its round cells; which, being separated, from the arterial blood, into the bladders it contains, serves to anoint and defend the muscles, and render them slippery: it is also furnished with a membrane, which distinguishes these muscles one from another; and, being also inserted betwixt their fibres, is mixed with  
the



the fleshy part of the whole muscle; and, when there is occasion, helps to temper the acquired sharpness of the blood; and proves of great service to that fluid, when violently agitated, and to the muscles that lie underneath. Being pressed and melted by heat and motion, and received into adipous vessels, it may be carried to the proper places, and at length be returned, more subtilized, by the veins; and, having performed its office, it may, perhaps, in some measure, exhale: but its unctuous part, doubtless, serves to moisten both the skin and the scarfe-skin.

Upon this lies a thick cluster of nerves, under the skin, interwoven into the form of a membrane; and rendered exceeding tough and substantial, by the hard coats of the nerves; it is every where interspersed with arteries, veins and lymphatics, from whence most that lie upon them arise.

The nerves, rising from this texture, form pyramids, which laying down their outward coat, received from the *Dura mater*, thereby afford a net-like body, first discovered by *Malpighi* in the feet, hands and tongue; but more accurately described by *Ruysche*, not only in those parts, but through all the body; forming various *Papillæ*, in several places; that reticular body having perforations, equal to the number of the *Papillæ*; which it not only sends forth, but strengthens and regulates them; being, as yet, not only nervous, but soft. In places endowed with exquisite sense, they are more visible and thick; as in the tongue, the nipples, the glans of the penis, the *Vagina Uteri*, the lips, the esophagus, the stomach, and intestins, where they have not a thick skin, but are only covered with a very fine coat at the fingers ends, and the ends of the toes, they are likewise covered with a skin which is very fine; but in the rest of the body, where the skin is thicker, they are fewer, less in magnitude, and not so sensible. The rest, of this reticular body hath neither blood-vessels, nor lymphatics; and, the scarfe-skin being pulled off, they appear less, and not so pointed and sharp.

From the same nervous intertexture, or branches,



rise several sharp, thin bodies, in several places, called hairs; some of which, also, spring from the oily glands, placed betwixt them, and growing long, are dried in the air; these are often contained in long sheaths, which serve not only to defend the skin, but to strengthen the pores.

A great many branches, from the arteries under the skin, being dispersed and interwoven one with another, send forth very fine vessels, outwardly apparent; which, in health, yield a thin, volatile, odorous, salt, invisible vapor, exhaling from under the scarfe-skin; but when these tubes are relaxed, or the humors too much agitated, it appears in the form of sweat.

The veins under the skin, in like manner, appear externally, in small branches, which are inserted into larger, but breathe out nothing; only receive the residue of the arterial blood and humors, and carry it back towards the heart; first mixing the finest lymphæ with the watry humors, and that lymphæ gradually with the thicker, then with the serum, and at last with the blood.

But, besides these, there are other unctuous pores, in the external skin, which emit and discharge oily exhalations, fit to soften, loosen, moisten, warm, and preserve it from exhaling too much. And still there are many others, perpendicular, deep and cylindrical, on the insides whereof, are abundance of orifices, which exhale liquids, there collected, that stagnate and dry into a worm-like paste, which, in the air, grows black, and is often the cause of many distempers of the skin.

Upon this lies the scarfe-skin, which, by reason of its tender vessels and subtle filaments, may be broke with the least force. It is easily separable from the parts underneath it, and divisible into abundance of *Laminæ*: it hath no vessels that can be rendered visible, nor is it endowed with sense; being composed wholly of prodigiously minute scales, cut into furrows and ridges, which, at the fingers ends are spiral, and very visible. In the middle of these fur-

rows,



rows, the pores, which discharge the sweat, lie hid, and on each side a row of nervous *Papillæ*, parallel and equal to one another; whence it appears, that the vessels, which discharge sweat, those that transpire exhalations, and the *Papillæ* which cause the sense of feeling, are defended by this thin covering, which neither hinders nor increases sense.

Sweat is discharged out of open orifices, under the scarfe-skin, rising thro' perforations in the reticular body, by excretory vessels, which are sent out from glands in the skin, called *Milliæres*; they lie upon the fat, and are dispersed all over the body, are closely joined together, and furnished with arteries, veins and nerves. The external orifice is covered with a hollow valve, which is round, and may be lifted up, placed under the scarfe-skin; being capable of discharging or restraining the humor.

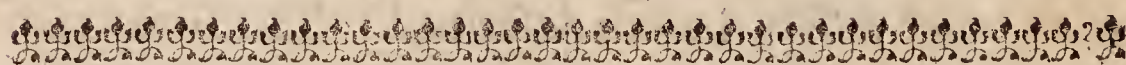
This is the chief organ of sweat, to which *Ruysche* adds other vessels, before described. The sweat thus separated is different, according to the variety of the weather, the soil, sex, age, temper, or as the emunctories differ; or according to the food, way of living, and the time of digestion, almost in the manner we said of the urine.

And indeed there is a very great similitude between them; as will appear, upon comparing one with the other. For, *first*, sweat greatly abounds in phlegm, as appears from its clearness and fluidity; *Secondly*, It contains many oleaginous, or sulphureous parts, as appears from the sandy color it communicates to linen; *Thirdly*, It has a considerable quantity of a briny salt, as we learn from its taste; *Fourthly*, It includes some alkaline parts, because it changes a tincture of mallow-flowers green; *Fifthly*, The alkaline salts, wherewith it is impregnated, are volatile, as may probably be concluded from its known volatility; however, 'tis certain, that it precipitates a solution of corrosive sublimate, and therefore has alkaline, as well as muriatic salt; *Lastly*, It contains some earth, as other mix'd bodies do; though this here is in a very small quantity, and so fine, as to be most easily reducible



into an impalpable powder. It follows, that sweat is a thin, serous fluid, mixed with some sulphur, a good deal of muriatic, but more volatile, salt, and a very little earth: the same properties being found in urine, it may be concluded, 1. That sweat and urine may supply each other's defect; and accordingly we find, that as sweat is promoted, the excretion of urine is diminished, and *vice versa*. 2. That they may be both provoked by the same remedies; thus, diaphoretics, failing to answer their intention, prove diuretic; and the contrary may be said of diuretics. 3. That sweat carries off many of the sharp salts, wherewith the blood abounds, and, by that means, may accidentally prevent or cure many distempers.

The quantity of this excrement is very small, in a sound body, except after an error in the six non-naturals. The first eruption of it is hurtful, but, by accident, sometimes does good.



## C H A P. XVII.

### Of Insensible Perspiration.

**B**ESIDES the vessels, which transpire under the scales of the scarfe-skin, there are some which open obliquely, and are so immensely small, that 125000 are supposed, by *Leeuwenhoeck*, to make their discharge in the space of one common grain of sand; from these, a most subtle humor continually transpires, in all the parts of the body; which was first observed by *Sanctorius*, to whom alone the glory and perfection of this discovery is entirely owing.

This exhalation arises from the whole external skin; as also through that of the mouth, nose, jaws, larynx, lungs, esophagus, stomach, intestins, bladder, and womb; so that the quantity of it exceeds that of all the other excretions, joined together: for, in *Italy*, when the body is strong and healthy, and after moderate living, that which is discharged, by the external skin, mouth and nostrils, is five eighths of what is taken into the body.

It



It cannot appear incredible, that an animated body should thus perspire ; when Mr. *Boyle* has observed the like, even in the most solid and inanimate substances. Besides, we see the air, when returned, in respiration, from the lungs, brings along with it a vapor, which, in the cold, condenses into considerable drops. We likewise find, that a finger, or any other part of the body, applied to glass, or polished metal, leaves a moisture behind it thereon ; and *Leeuwenhoeck* assures us, that a quantity of this matter may be collected, by holding the naked arm in a proper vessel, without any mixture of sweat : but the experiments of *Sanctorius* are, alone, abundantly sufficient, for the proof of its existence. The causes of this excretion are various, and depend upon the continual action and re-action of the parts, both solid and fluid, as has been already explained ; tho' the matter of it must chiefly proceed from the fluids, and probably retains, the same nature with the more volatile parts of the blood ; that is, it may be a mixture of phlegm, volatile salt, and oil, in certain proportions.

The great subtlety of this fluid, the uninterrupted continuance, and large evacuation thereof, seeming lightness to ones self, and the weight of the body increasing in the scale, and its increase after sleep, are arguments of the presence of perfect health ; and these are the chief means to preserve it. But when this fluid recedes from these conditions, it is almost an infallible indication of diseases, and, perhaps, the cause of them also.

It is preserved, increased and restored by the viscera, vessels and fibres, being in full strength ; by exercise of the body, till a gentle sweat begins ; by venery, moderately used, and occasioned by the natural strength of a sound body, not by the longing of the mind ; by seven or eight hours sleep, the body being well covered, but not pressed with too great a weight of bed-cloaths ; by the effects of moderate joy ; by youth ; by wholesome food, that is light, fermented, and not fat, but moderately season'd ; and, lastly, by



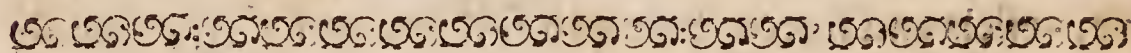
by a pure air, that is serene, dry, heavy and cold: but whatever things are contrary hereto, as also the increase of the other excretions, diminish, hinder, and deprave it.

From hence we may understand, not only what the matter of this perspiration is, but also its cause, effect, necessity and use; being designed to promote agility of body, a softness, and a restoration of what is destroyed; but especially, to render the nervous *Papillæ* moist and lively, apt to be affected with objects, and always ready to convey the impressions thereof.

And from hence it also appears, that if sweat be increased, and its vessels enlarged, perspiration must needs be diminished, and its vessels compressed. This perspiration, also, is turned into sweat, by violent motion, and too much heat; though, by moderate motion, and gentle heat, it is very much promoted; but nothing can be more serviceable to promote it, than a gentle friction of the skin, long continued.

But large and continued sweating greatly fatigues and weakens, and this always necessarily happens to infirm persons, and those that are consumptive, or phthysical, in fainting fits, or at the approach of death.

It also appears from hence, why, both presently upon eating, and a long time after, perspiration diminishes in a sound person; also, why, betwixt the fifth and the twelfth hour after feeding, perspiration is the greatest; and likewise, why riding on horseback, or in a coach, sailing, or great motion upon the ice or snow, so greatly promote it.



## C H A P. XVIII.

*Of the Nutrition, Growth and Decrease of the Body.*

**T**O enable a human body to make a due use of all the motions of the humors, vessels and muscles already mentioned, without prejudice thereto, an



an aptness to motion is required in the vessels, muscles and fibres themselves: now, to this end the parts, which are coherent, ought partly to be freed from, and partly to remain in contact, which cannot be, unless the greater parts consist of the most small, thin, and short ones; nor will that happen again, unless a renovating humor constantly pass betwixt them, to hinder their growing together; the whole body, therefore, as it is flexible, and subject to changes from contact, ought of necessity to consist of small vessels.

But this very motion, being continually and violently performed, in vessels of such a tender fabric, the least parts must needs be thereby worn off from the solids; and thence, being mixed with the liquids, be moved round, by the perpetual circulation of the juices, as well as by the action of the muscles, and transpire; in the mean while, the fluids being ground small, by continual attrition of their parts, and drove to the vessels through which they transpire, are quite excluded out of the body; and thus the animal machine, from the very condition of its frame, is soon destroyed.

It is therefore, requisite, for the due continuance of life, that as much matter, and of the same kind, should be continually restored to the humors and solid parts, as was lost by those motions; and this action is called nutrition.

The humors, worn away, are again supplied, as to their matter, by meat, drink and air; as to the qualities required, those are produced by the concurring assistance of the parts hitherto explained, and, by means thereof, applied to the vessels where they are wanting.

The nutrition of the solid parts, which is the more obscure, may be understood by the knowledge of the following particulars. Every solid part of the body is composed of other less solids, very like to the greater; the vessels, of smaller vessels; and the bones, of smaller bones; and this manner of structure proceeds beyond all the limits of sense, assisted by what art so-



ever; as *Malpighi*, *Ruysche*, *Leeuwenhoeck* and *Hook* have shewn, by accurate experiments; yet, it scarce proceeds *ad Infinitum*, as appears by the nature of the nourishment, and the fluids themselves. But microscopes, injections, the least imaginable wounds, vesicatories, consumptions, and the withering away of the body, inform us, that the solid parts, in respect of the humors, are but very small; for it is almost demonstrable, from the consideration of the rise and generation of the vessels, and the resolution of the greater canals into their least constituent parts, that the solid mass of the whole body, is almost wholly composed of mere nerves, considered in their communication, and primary composition.

And, truly, all that mass, except an incredible small particle, at the first grew together, from those which were before the most subtile liquid of the *Colliquamentum*, almost all which goes to compound the body; being much like the nervous juice, according to *Malpighi*: for the white of the egg does not nourish, before it hath been long brooded upon, that is, till that thick humor hath passed thro' a great many degrees of fluidity, by several changes, to fit it last for the purposes required; and even then, when it comes to supply the embryo, it is very thick, and must be much more subtilized in its vessels and viscera.

The first, tender, solid parts, being made out of this most subtile humor, which are then almost fluid, they again pass through a great many different degrees of solidity, before they arrive at the perfection of solid parts; as appears from *Malpighi* and *Ruysche*, and even from the different parts themselves.

From whence it appears, that the solid parts, in their first origin, only differ from liquids, whence they spring, by rest, cohesion and their figure. Therefore, such a particle, while fluid, will become part of a solid, to be formed thereof, as soon as the power, that causes it to cohere with the other solid parts, shall act; by what means soever it be.

And this cohesion of the parts is best produced in a fibre already formed, if, in the solid body, there  
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be a sufficient place left by that particle which was lost, and, at the same time, another particle in the fluid of equal bulk, figure and nature; and endowed with sufficient force to thrust it in, or fit it to that place.

There will, therefore, be a true nutrition of the solids, in the smallest vessels, which, by addition, become greater, that is, in the nerves or vessels like thereto; which, since it cannot be performed without a liquid be brought into these vessels, it seems plain, that the most immediate matter of nourishment, is the subtle, nervous juice, or some other like it; and, therefore, appears to be performed and produced from the last, and most refined actions of nature; and, that it may be performed well, all the preceding actions ought to be perfect.

The chyle, therefore, may fill the greater vessels, but cannot recruit the solid parts; but, being attenuated, altered, rarified, mixed, and made fit to pass through some vessels, by the force of respiration in the lungs, it is rendered the more proper, indeed, but still not fit matter for this use.

However, by the repeated effect of the lungs, viscera and vessels, it becomes a white, tenacious, forming liquor, almost without smell, that thickens by the heat of the fire, or in spirit of wine; being then like the white of an egg, and called serum; and, therefore, is such a fluid, as hath all the requisites, which ought to be in that; whereof, experience teaches us, all the solid parts of an animal body are constantly made or formed, only by incubation, or a constant heat and digestion. Thus, then, the matter is brought a degree nearer, but yet is not quite fit for nutrition; much less is red blood, which never enters the smallest vessels.

But, as the heat of incubation, so the action of the viscera and vessels, occasions divers changes, on this circulating serum, till part of it be turned into such a subtle humor, as is here required; and, being consumed, it is again supplied, and this, at length, becomes the true and immediate matter of nourishment; which, how simple it is, how insipid or without



out smell, will appear from the fire, putrefaction, or the art of chymistry, for it leaves nothing behind, but a pure and exceedingly light earth.

Nor can this matter be prepared, without undergoing the fore-mentioned alterations. But the same humor may, by too often and repeated turns of circulation, grow sharper, or lose its liquidity, and become thick; being drained of its oily parts, and rendered pungent by salts, and then it is unfit for this purpose; and may, perhaps, be partly discharged by perspiration, and partly by urine.

There is, therefore, a necessity of new chyle, and consequently of aliment, to supply this nourishment.

As to the manner how, and the cause why, nutrition is performed, that may appear from what follows. The humor being forced forwards, through a full, conical, cylindrical, elastic, or stiff and rigid tube, if it flows from a broad part into a narrower, or with a resistance against its motion, it will endeavour to extend the sides of the canal, according to its longer axis; and this happens all over the body, except in the veins, and the cavity of the receptacles. And by this force, though small, being constant and repeated, the vessels will, by degrees, and insensibly, be lengthen'd; and, by growing longer, will become thinner, and soon be more and more attenuated. And, by this means, the utmost extremities of the vessels, which are smallest, will be less coherent, and next to a state of dissolution. And thus the extremities of the vessels will be render'd much finer, and weaker, and little different from fluids. Whilst, therefore, this motion perpetually proceeds, in a continual propulsion, it must needs happen, that the last particles of these fine tubes, being worn away, will again put on the form of a liquid, in whatever part of the body they remain: and then the smallest parts, which compose the finest fibres, by their union, will be so mutually separated from one another, as to leave small intervals in those places, where they before grew together; and this will constantly happen every where, as long as life continues,



tinues, especially where it is strong, and the action of the body violent.

But the same humor, wherein all this happens, contains a great many such particles, as were separated or lost, which it carries, applies, and adapts to those very intervals, with that very force, with which it endeavours to break the vessels; and then fixes, fits, and fastens those intercepted particles in these cavities; so that they grow together as the former: for the matter, the preparation, and application thereof, with the force of motion, will always continue the same; and therefore, what is lost will be easily restored; and so the solid parts remain as they were, that is, be nourished and preserved continually.

And this shews the wonderful wisdom of our maker, that the same cause which inevitably destroys, shall also, at the same time, repair the structure of our bodies; and that too according to this rule, that the greater the loss, the larger shall be the supply; and that those parts, which, by the actions of the body, are first worn, are always the first supplied.

It is plain then, that the more tender those vessels are, the newer, and the nearer to the moving cause, so much the easier they are stretched, distended, destroyed and renewed; and, consequently, our bodies, the nearer they are to their origin, the more they grow and increase.

Whilst this action goes forwards, the greater vessels are more distended by the liquor they contain; but, at the same time, the small vessels, which, interwoven, compose the membranes of the greater, are more compressed, dried, and grow nearer together, which adds strength to the fibres, at the expence of vascular property; so that our vessels in time turn to hard ligaments, and the humors become firm and solid. By a concurrence of these causes, the solids become strong, hard, stiff and thick. Therefore the vast number of vessels, that are in an *Embryo*, gradually decreases as age comes on; and, for the same reason, on the other hand, as weakness decreases, strength increases: and so in young persons, the quantity and  
vigor



vigor of the humors exceeds that of the solids; but in old ones, the solids in quantity and strength exceed the liquids: from whence the means of increase, decrease and death of the body, from old age alone, plainly appears; with the causes and different appearances thereof.

Whoever considers this whole account, and then compares those accidents therewith, which happen to the body, will clearly perceive this to be the state of the case; for the whole cuticle every where perpetually scales off, perishes, and renews again; the hair, nails, teeth, cut off, pared and wore, grow afresh; and parts of the vessels and bones, taken away, in a short time, return on every side; and if the filth in the extremities of the vessels, throughout the body, that is either worn off, or collected there by exhalation, be viewed in water, with a microscope, after being evaporated, or diluted, it appears to consist of solids and fluids; and the same, when obtained by washing, rubbing, or abrasion, exhibit the like appearance.

From hence it likewise appears, that the increase of the bulk of the body, as to the whole habit, in fleshy, and fat grown people, depends not upon the increase of the solids; but on their being extended into greater cavities, and fill'd with congested, stagnant humors; for which reason fatness is troublesome, weakens and suffocates: so that there is a great deal of difference betwixt repletion and nutrition; since the one strengthens and thickens the vessels; the other weakens, relaxes and extends them.

From hence also appears the reason, why the fabric of the solids is not dissolved by the liquid contents; and why our machine continues so long fit for motion; why, when the nerves are by any means corrupted, the part, to which they lead, loses its nourishment; why, in an embryo, there are no solids, in a fetus few, and in old men many; so that even the nerves, tendons, arteries, and receptacles, first becomes cartilaginous, and then bony.

From hence moreover we may understand, by what  
diffe-



different and various means, the circulation of the humors of our body is carried on, and how different the effects thereof; and that though it may seem easy, yet that it is difficult or impossible to determine, how often, in a given time, the humors, in general, circulate once through the heart.

Thus far the industrious *Boerhaave*, whose opinion of nutrition and decrease seems well grounded, and every way rational; yet, tho' this action appears most likely to be performed by the nervous juice, or something like it; since the mass of blood is too thick, as well as the cruder chyle, to penetrate into the finer vessels; yet, where the blood-vessels do penetrate, the arterial blood seems to have a great share herein; not only by stretching the vessels lengthways, and dilating them, but by affording some part of the matter whereof they are composed, especially after loss of substance, either in the fleshy parts of the muscles, or the more solid ones of the bones.

When there is a loss of substance in a muscular part, the new matter that supplies the deficiency and incarns, is of the exact color of blood, and seems to be formed out of its mass: the spirits or nervous juice may, indeed, be mixed with it, and act as a plastic power, in forming the vessels; and may also prove a cement to agglutinate the thicker parts of the blood, and determine them into a due frame and order.

When a callus is thrust out of a bone, though the substance, of the bone it proceeds from, be white, yet the callus is perfectly of the color of the blood, which color it loses not, till the vessels are compressed so close, that they admit no more blood into them, and then, by degrees, they degenerate therefrom; and, being no longer of a fleshy substance, acquire the color of a bone, admit of no nourishment, but what is suitable to a bone, and adapted to pass into its pores.

But, indeed, it matters not, whether a part receive its nourishment from the nerves, or arterial blood, or both conjointly; or whether the lymphatics are nourished by their lymph, as bones



are kept moist, and preserved by an oily mucilage, separated into their medullary cells; since, as the animal spirits are distributed to all the points, throughout the whole body, there is nutritious and nervous juice mixed with all kinds of humors, either to nourish and supply the defects of any part, or prove a means to apply and adapt some other juice to that purpose, whose parts are fitly prepared to enter into those vacancies that want to be repaired.

It likewise seems highly probable, that the lymph has no inconsiderable share in this action; it being a fluid that appears extremely well fitted thereto: for, *first*, it is thin and penetrating, to enable it to insinuate into all, even the minute points of the body, and to repair what is wanting. *Secondly*, It is viscid and unctuous, so that, when separated from its phlegm, it may fix and glue the parts together. *Thirdly*, It is smooth and insipid, and therefore will not irritate and dilacerate the present or remaining parts, instead of repairing their loss, or affording the wanted supplies. *Fourthly*, It is pellucid, or whitish, the color of the flesh, when freed from its blood. *Fifthly*, It is universal; and all the parts of the body must be nourished and supplied. And, *lastly*, 'tis endowed with a slow motion, that it may gently slide into the vessels that require it. Now all these properties being found in the lymph, and some of them, perhaps, in a greater degree, than in any other fluid of the body, renders it exceeding fit to contribute to nutrition; nay, there are those, who suppose this, alone, to be the actual cause thereof. Experience, also, seems to countenance this opinion; for, in well digested wounds, we behold such a kind of fluid, oozing out on every side; by means whereof the cavities of them are filled up, and the parts consolidated together. But whether this fluid be, of it self, sufficient to make and recruit the solids of the body, more than the animal spirits, I will not here presume to determine, though arguments are not wanting to countenance such an assertion.



## C H A P. XIX.

*Of the Touch, or Sense of Feeling.*

**T**H E organ of feeling, which receives different impressions and sensations from the various bodies which affect it, and communicates ideas of those sensations to the common sensory in the brain, is composed of soft, pulpous, medullary *Papillæ*, which are nervous and pyramidal, rising from hard nerves under the skin, having deposited their outward membrane, and so become very sensible; they are continually moisten'd with a very thin liquor, and defended with the cuticle, or scarfe-skin, which is very solid and thin. They lie hid betwixt the sinus's and the cavities, under the cuticle, in the parts proper for exercising the touch; as in the tongue, the ends of the fingers and toes; and have a power to contract and thrust themselves out again.

It is very remarkable, that, in the rest of the body, they are perpendicular; but, that about the ends of the fingers and toes, they lie stretched out lengthways; from whence, being joined to the cuticle, they are folded up in it, as in a sheath, and, being dry, are there condensed into the nails, fitly contrived, by the access of the cutaneous vessels, which are thick, to defend the *Papillæ*, and hinder them from growing callous.

The touch, then, is occasioned, if the end of the finger be applied to examine an object, when the *Papillæ* are extended by the attention of the mind, and gently rubbed upon the superficies of the body. Thus a certain motion is received by these *Papillæ*, the effect whereof is conveyed to the common sensory, and excites in the mind the idea of hot, cold, moist, dry, soft or hard, smooth, rough or figured, of a body in motion or at rest; of distance, tickling, itching or pain.

From whence it appears, why we feel pain when a part is rubbed, or the cuticle scalded, worn, or



burnt away ; or why the feeling is lost, when the cuticle is become thick, hard, callous, or spoiled by a cicatrix ; what is the cause of that surprizing and uneasy sensation, that proceeds from trembling, or the fish called *Torpedo*, which gradually ends in numbness ; also, why, at the ends of the nails, which are fixed to the skin, and at the roots thereof, pain is so violent ; and, lastly, why there is the most acute sense of feeling where nails grow, and where the furrows of the skin are spiral.



## C H A P. XX.

### *Of the Sense of Taste.*

**O**N the back of the tongue, especially at the point and sides thereof, under the skin, lie obtuse *Papillæ*, which appear of three kinds, and rise up in a tongue that is alive, hot, moist, thrust out, and applied to taste any thing, particularly when the person is hungry ; but, in dead bodies, they disappear. They rise from a nervous body, which lies upon the musculous flesh of the tongue ; from whence they pass through the reticular body, penetrating it, as we said of the skin ; and then they are placed under the external membrane of the tongue, erect in small sheaths, which defend them from things that are too sharp, and the heat of what is taken into the mouth. These *Vaginæ* are porous, and stick out so far, that, when the aliment is squeezed, they run deep into it, to receive the object.

And it appears not improbable, that these *Papillæ*, which are so numerous, rise from the ninth pair of nerves, which are wholly bestowed upon the tongue ; but that the branch of the fifth pair serves to its muscular motion, as in other parts.

Experiments, diligently and accurately made by *Bellini*, evidently prove, that these *Papillæ* are the organ which receives the impressions of taste, from objects applied thereto ; and that the others of the mouth,



mouth, tongue, jaws and palat, do not act therewith : but, perhaps, those that lie in the cheeks, next to the place where the *Dentes molares*, or grinders, meet, may be concerned herein.

That matter, from whence art extracts salt or oil, be it in vegetables or animals, mixed or separate, is the true object of tast, as salt, soap, oil and spirit ; and the same holds true in fossils, or minerals dug out of the earth.

Tast, therefore, is occasioned, if the matter of the object be attenuated, and mixed, as commonly, with the saliva, warmed in the mouth, and applied to the tongue by their motion ; which, being insinuated into the pores of the membranous *Vaginæ* of the nervous *Papillæ*, and penetrating to the superficies of the adjacent *Papillæ* themselves, affects and moves them ; and so communicates the impressed motion to the common sensory, and excites in the mind the idea of salt acid, alkali, sweet, vinous, spirituous, bitter aromatic, hot, sharp, austere, or tastes variously compounded of these.

Hence it easily appears, why the same object occasions different tastes, according to the difference of the age, temper, sex, disease, custom, or things which had before possessed the organs. From hence likewise we may understand, why what affects the tast briskly is painful, as those things that are salt, aromatic or spirituous, if applied to the naked nerves of the tongue, when excoriated ; and why things that relish well or pleasantly are refreshing ; and, lastly, why water, smooth oils, and earth without salt, are insipid.



## C H A P. XXI.

### *Of the Sense of Smelling.*

THE nostrils which are large, and, from a broad entrance, grow narrow, the passage tending upwards, with a duplicature, are most apt for smelling,



and to attract with the air, draw together, and force the volatile, odoriferous parts of bodies against their superficies; especially when streighten'd by the united action of the *Contractores alarum nasi*; which, rising fleshy from the foremost and lower part of the fourth bone of the upper jaw, are inserted into the *Ala*, sometimes with the addition of *Eustachius's* semilunar one.

The cavity of the nostrils, is the space that receives the frontal sinus's, which, for the most part, are formed betwixt the remote tables of the *Os frontis*, under the protuberance below the eye-brows, from whence they open into the nostrils, on the higher part next to the upper bone of the nose. They contain betwixt them, the mucous membrane of the nose, which encompasses the whole internal space of the nostrils; whence the mucus that is collected falls down thereinto. The little cells, or cavities, of the *Os cuneiforme*, under the upper spongy bone of the nostrils, opening by several distinct perforations into the cavity of them, receive the mucous membrane, and being covered with it, separate the mucus, and discharge it this way. The large *Antra Highmoriana*, formed in the upper jaw, opening into the same cavity, receive the said membrane, and separate from, and discharge a mucus into the cavity of the nostrils.

Besides these, in the cavity of the nostrils, lie hid very artificially, and in different places, the four little spongy bones of the nose, two in each nostril; one is united above and before, to the upper part of the jaw-bone, where it is joined to the *Apophysis* of the *Os frontis* at the inward corner of the eye; the other below, in the internal part of the cavity of the nostrils, joined to the bone of the upper jaw. These four bones are wonderfully made of very thin plates, finer than paper, and so placed together, that they form a great many hollow cavities; into which the mucous membrane is so insinuated, that it enters, goes out, and entirely covers the superficies thereof, leaving the cavity open. The cavities of these small bones,

and



and of all the cells, open freely into the cavity of the nostrils.

The nostrils are lined with a thick, soft membrane, furnished with a vast number of small arteries, and a great many round, glandulous substances, as also, very fine vessels, which discharge a thin lymph. This membrane is thoroughly insinuated to the six sinuous cavities, and the four small cells of the spongy bones; from whence, in the narrow cavity of the nostrils, its surface is wonderfully increased, but so, that one part is not in the way of the other.

The olfactory nerves, proceeding to the *Os Ethmoides*, without the *Dura mater*, their tender fibres pass through the perforations in that bone, that are penetrated by a case from the *Dura mater*; through which they tend from the *Os cribriforme*, and are presently distributed to all that large superficies, and even into all the sinus's and cells thereof.

From whence it is plain, that the expansion of these nerves is very broad; nor are any nerves in the whole body so soft and bare; and therefore so easily hurt, or otherwise affected, as in this part.

In all the numerous glands in this membrane, that is also plentifully stocked with arteries, which appear as if they lay in bundles, a soft, fluid humor, without smell or color, and almost insipid, is constantly prepared and separated, to moisten the nerves, render them slippery, and defend them in all their distributions. This, when out of motion and stagnating, is collected together and thicken'd, and being continually discharged, let the body be in what posture soever, it flows down, and is called mucus; which preserves these tender, naked nerves for many years, which would otherwise be soon destroyed.

And, lest this humor should grow hard, by stagnating too long in these cavities, or, becoming thick, should be unfit to pass out through the narrow passages thereof, a branch of the fifth pair of the nerves is here distributed, being also united with the nerve of the sixth pair; which, being irritated, the intercostal and *Par vagum* are also affected, that supply



the muscles serving to respiration ; whence the air, in the action of sneezing, being violently driven into these cavities, the mucus is cleansed away.

Now, that part of animal, vegetable, or mineral substances becomes the object of smelling, which is spirituous, oily, salt, or soapy, when so divided as to fly in air : and it is evident, from experience, that the subtle matter, which lodges in oil, and called spirit, is what chiefly produces the effect of smelling ; for, this being absolutely separated from odoriferous bodies, the remaining part hath scarce any smell ; and, that being poured upon other substances communicate scent thereto.

If the *Aspera Arteria* be cut in a live animal, and laid open by a wound in the neck, the sense of smelling ceases, though the object be never so strong ; and, when air is drove out of the nostrils in expiration, no smell of external objects is perceived ; and little or no scent is observed upon holding ones breath ; but it is chiefly perceiv'd when the breath is drawn thro' the nostrils ; and the stronger and thicker respiration is made, the more the sensory is affected.

The smell of odoriferous objects is increased by motion, heat, triture, the mixture of several bodies, as a careful one of salts, with odoriferous, oily substances.

The sense of smelling is, therefore, occasioned, when odoriferous effluvia, contained in the air, are strongly drawn in through the nostrils, and pressed against the olfactory fibres ; the figure of the nose, and the position of its bones opposing them, and thus acting upon them ; which action, being communicated to the common sensory, excites the idea of the smell of acid, alkali, aromatic, putrid, vinous, &c.

Hence we may understand, what difference, or affinity, there is betwixt smelling and tasting, or their objects ; why smells, in a moment, fetch one to life ; and why sometimes they act as medicines, or poisons, and occasions various kinds of distempers, and death ; and why, in different persons, different smells have various effects ; why birds, whose bills  
and



and nostrils are long, and bones very spongy, enjoy a more exquisite sense of smelling; why very subtle exhalations, even when the body they flow from, does not thereby decrease in weight, can afford such strong and lasting scents; by what means a fetid smell, evaporating out of the putrefied parts of animals and vegetables, being once impressed upon the nostrils, becomes so lasting, offensive, and hard to be removed; why the strongest smells promote sneezing; of what use the constant humor and mucus are of in the nostrils; why the sense of smelling is dull in one that is kept long awake, but render'd brisker after sneezing; whether this humor be not serviceable in purging the brain, as well as moistening the nostrils; and whether it be thick when first separated, or becomes so afterwards; why there is so great a consent betwixt the muscles serving to respiration, the viscera in the abdomen, and the cavity of the nose; and lastly, we hence see, whether sneezing be a convulsion, and therefore fatiguing, often creating pain, and sometimes death; in the mean time exciting and stirring up the motion of the brain and spirits, and increasing that of all the humors; and why it often happens in a morning, and for what use.



## C H A P. XXII.

*Of the Sense of Seeing.*

**T**H E Eye is defended both above, below and sideways, from accidents, and little foreign bodies that might fly into the *Cornea*, by a thick, arched and prominent bush, placed on the rising part of the *Os frontis*, called the eye-brow; and also by stiff, erect, arched hairs, that spring from their small, bulbous roots, on the outward margin of the eye-lids, termed *Cilia*.

The muscle which depresses the eye-lids, rising on each side from the bone of the nose, where it is joined to the foremost apophysis of the *Os frontis*, is inserted



inserted, with slender tendons, under the elevated part of the eye-brows; this acting, defends the part from dirt, and is also a shade to the eye, when placed in too strong a light; when contracted, it brings the eye-brows towards the upper eye-lids, and forces them nearer to one another. The frontal muscle also elevates the eye-brows, when there is occasion. Both the eye-lids are membranous, thin, pliable, full of vessels, and furnished with nervous *Papillæ* on the inside; they are always moist, being defended with a broad, arched cartilage, when they touch each other; they are either open, shut, or, by repeated twinkling, equally defend and cleanse the eye; for the elevator muscle of the upper eye-lid, rising carnosus and narrow from the bottom of the bony orbit, and, proceeding to the *Attollens*, or elevator of the eye, being dispersed into small, tendinous fibres, is inserted into the whole upper part of the tarsus of the eye-lid, and, when moved, lifts up the upper eye-lid without wrinkles. But the orbicular muscle, rising from the greater bone of the nose, and being dispersed in orbicular fibres, through both the eye-brows, with a moderate motion, joins the eye-lids together, contracting them like a sphincter; and, by a stronger contraction, presses the ball of the eye, and squeezes out the tears, upon the external superficies of the eye; which is thereby cleansed of its filth, and the eye it self washed. The lower eye-lid is opened by the spontaneous contraction of the fibres, distributed in the cheek.

And, lest the eye-lids, by a continual twinkling motion, should be excoriated, in each cartilaginous edge, are placed small glands, of a yellowish color, that prepare a humor, which appears composed of wax and oil; and, discharging it out of wide orifices, anoint their edges therewith. These orifices are the extremities of small vessels, placed in a curved, winding position, which arise and are continued with the arteries, and distributed along with them, though they have no glandulous fabric.

The large, conglomerate gland, called *Innominata*, being



being broad, compressed and rough, placed within the orbit, towards the outward angle of the eye, near the rough chink, and inclosed in fat, is endowed with arteries, veins, nerves, lymphatics and ducts, which carry a humor to the eye, prepared out of the arterial blood, of a saline, watry, clear and smooth disposition, discharged always in a small quantity, but more plentifully when the eye is rubbed or compressed by the orbicular muscle. It lays down this humor betwixt the ball of the eye, and the inside of the upper eye-lid; it moistens, washes, and makes the eye slippery, and prevents it from sticking to the eye-lids. When this liquor abounds, it turns to tears; and perhaps a like humor is made for the same use in the small glands of the upper eye-lid.

It is certain, both these humors are deposited in that space, along with the fordes, by means of the figure and determined concourse of the edges of the eye-lids, which, being shut, leave free liberty, in the greater corner of the eye, to receive them; being formed in a spongy caruncle, placed there on purpose; here the grosser part is fixed, and, when collected by the roughness of the said caruncle, is dried and changed into a white substance. The more liquid part, with a motion surprizingly determined, is pressed upon the dilated perforations, placed in the extreme corner of each eye-lid, which are called the lachrymal points; from whence the lachrymal ducts arising, meet together, beyond that caruncle, in the bladder of tears, placed in a channel in the nose, made of the concourse of the *Os unguis*, and the foremost bone of the upper jaw, from whence it is carried, by a canal that is always open, into the cavity of the nose, immediately under the lower spongy bone. From whence appears the reason, why those that cry have a dropping through the nostrils, and why, in people under no uneasiness, no lachrymal humor appears.

Thus the eyes exposed to the air are kept moist, clean, clear, slippery, soft and moveable, as well as warm; are easily freed from any thing rough or sharp



sharp that may fall into them; remain in a fit state to be easily and equally expanded by an internal distending cause.

The fabric of the eye, and the action depending thereon, will best be understood, if we begin with the optic nerve, and so proceed to consider all the other parts and their offices, as they depend upon this.

The optic nerves proceed from the extremities of the medullary substance, which is under the *Corpora striata* of the brain; from whence they tend downwards, and are accurately united under the *Infundibulum*; then separating again, they proceed to the round perforations of the bony orbits of the eye, and penetrate into the bottoms thereof; all this way they are very soft and porous, being only covered by the thin membrane of the brain, and furnished with a great many branches, or twigs, of arteries, in their passage under the brain. In their passage through these perforations, they are covered also with the *Dura mater*, which is fastened, as a case for them, to the other membrane; and thus they pass into the cavities of the bony orbits of the eyes, where the *Dura mater* is also furnished with abundance of arteries.

These bony orbits are covered inwardly with the periosteum, and filled with fat, which receives the ball of the eye like a cushion, keeps it fast, moistens, defends it, and renders it fit for motion. The optic nerve, having entered the orbit above the fat, and, being covered with the *Dura mater*, expands it self nearly into a perfect globe, membranous and hard, almost like leather, and encompasses the whole eye; growing gradually thinner, and much more so, as well as clear, and prominent in the fore part. This coat is called sclerotis, where it is dark; and cornea, where it is clear and thinner. It chiefly serves to keep the part firm, and to support the vessels and muscles, with their tendons, for the arteries and nerves to pass through it.

The membrane which involved the optic nerve from the *Pia mater*, and also entered the orbit along with it, encompassing the hollow superficies of the *Sclerotis*,  
and



and being divided into two tables, and supplied with a great many small arteries, distinguished by different courses, according to *Ruysche*, proceeds to that place where the *Sclerotis* forms the *Cornea*; whence, parting from the sclerotis inwardly, it affords a very thin membrane that encloses the vitreous humor; and secondly the coat called *Uvea*, in the middle of which is the pupil. The coat which is next to the *Dura*, or *Sclerotis*, is called *Choroides*, and that which is within it *Ruyschiana*.

Whilst the edge of the choroides forms the uvea, it receives nerves from those which go to sclerotis; which perforating this and the *Choroides*, and, being here communicated to it, are divided into a great many branches. Of these and the membrane the external muscular fibres of the *Uvea* are formed; which, from their origin tending towards the center, end in an orbicular virge, composed of orbicular muscles, and form the space and figure of the pupil; this virge, when turned backwards and inwards, and being three times bigger than the external part, receives the right internal fibres of the *Uvea*, and binds them together. From whence it appears, that the orbicular fibres contract, and the longitudinal dilate the perforation of the *Pupil*. But the small transparent membranes, tying the fibres together, are covered over with a dusky veil, on that side which is towards the back parts of the eye.

In the *Uvea* there is a wonderful contexture of arteries, formed in rings, and branches arising therefrom; though those arteries, whence these spring, had before formed nearly the same kind of wonderful structure in the coat called *Choroides*.

If we consider the surprizing provision made in this part, it will teach us, that the greatest degree of attenuation must be here given to the most subtle humor, and an easy return of the thicker part.

That very thin membrane, which rises from the place just mentioned, of the circumference of the *Choroides*, is also furnished with curved, muscular strings of fibres, which embrace the rising, gibbous, annular



annular superficies of the vitreous humor, where it bulges out beyond the crystalline; the beginning of these is fixed in that orb they rise from; their termination being moveable in that virge of the vitreous humor, where it leaves the crystalline lens; the distance of these is greater, than of those which are in the *Uvea*, and the same is rendered opaque. The sanguiferous vessels are distributed here, in the same manner as in the *Uvea*.

The flexible, vitreous humor is contained in its own proper membrane, fixed in the cavity of the *Choroides*, by very small fibres, or ligaments on every side; and is so thin, that it is scarce visible, and the more so, by reason of its transparency: but it appears when damaged by the dropping of water upon it from the vitreous humor.

In the cavity formed in the middle superficies of the fore side of the vitreous humor, lies, on the lower part of that surface, the crystalline lens, kept there, by a connection with the membrane of the vitreous humor, and also by a thin membrane of its own: but these membranes, and the bodies contained in them, are so clear and thin, that they are quite transparent; yet, that they are contained in vessels is not only evident to reason, but also, in larger animals, to sense.

The internal medullary part of the optic nerve, being perforated in the middle, enters into the bottom of the ball of the eye, so that the place of its entrance, in respect of its height, is in the middle; but in respect of its breadth, it is so situated, that it almost possesses a third part of the distance from the inward corner of the eye; the diameter of the eye being measured breadth-wise; so that the axis of the optic nerve does not fall upon the place of its entrance, but recedes much towards the outward angle. The medullary part having thus entered the eye, it is presently expanded under the vitreous humor, and rising up on every side, it is furnished from its ingress with large arteries, which are continued therewith in all its expansions; it hath also lymphatics,  
which



which appear like a very tender mucus. This coat is called the *Retina*.

The cavity of the eye, formed of the concave cornea, and the convex superficies of the vitreous and crystalline body, is full of a thin, transparent, sub-saline, scentless humor, which is soon renewed, as it soon exhales; it extends the *Cornea* into an equal convexity, and keeps it so; and sustains the incumbent *Uvea*. In youth it is very liquid, and by degrees grows darker, and in old age white; it seems to proceed from the arterial blood, prepared in the *Choroides*, and more perfectly elaborated in the annular arteries of the *Iris*, and vitreous humor; being further attenuated by small lymphatics, there arising from the arteries, and from thence continually sweating through their open perforations, in the internal superficies of the *Cornea*, *Iris*, *Uvea*, and membrane of the vitreous and crystalline humor into this cavity; from whence it is continually received again by the mouths of the lymphatic veins, without leaving any feces behind it. For which purpose, the ducts, assigned by *Nuck*, are very unfit. This liquor, thus supplied and renewed, is very serviceable in preserving, moistening, and rendering these parts slippery, as well as continuing their transparency.

The crystalline humor is firm and spherical on each side, composed of numberless, spherical segments, that are fibrous, closely united and transparent; 'tis thicker than either the aqueous or vitreous humor, and situated for the axis of vision to pass its center; it is nearer to the *Cornea* than the *Retina*, consisting of an infinite number of vessels; as appears by drying of it, and the weight it loses, as well as by the contraction of its bulk. It receives vessels from those that are continued thereto.

The vitreous humor is very clear, flexible, thicker than the aqueous, and vascular on every side; as appears when pricked, by the humor running out of the puncture; which is also confirmed by drying of it; and therefore, doubtless, a humor continually circu-



circulates therein. The arch-like fibres being contracted, the annular circle is depressed, the middle of it rising up; and the crystalline humor elevated and brought to the *Cornea*, and moved further from the *Retina*; when the fibres are relaxed, the annular part is restored to its place; when it again subsides in the middle, and the crystalline humor being brought nearer to the bottom of the eye, it performs its office.

The eye thus formed, and placed in the orbit, it receives on its fore part a membrane, called *Adnata*, which is loose and moveable, and rises from the periorbitum, at the external circumference of the orbit; it is full of vessels, and, being transparent, covers all the fore part of the eye, which strengthens the ball thereof, being watered and kept moist to make it moveable.

Then four muscles, rising fleshy out of the circumference of the great perforation of the orbit, ascending about the bulbous part, and growing tendinous about the middle, are so fixed to the *Sclerotis* that they lift up the eye, depress it, bring it towards the nose, or from it, hold it fast, turn it round, compress or lengthen it out, just as they act, either separately or conjointly. Next, the upper oblique muscle, rising, with a fleshy beginning, from the lower part of the orbit, near the *Musculus attollens*; being furnished, in its progress, with a fleshy belly, and changed into a round tendon, which passes through the trochea, or pulley, within the inner part of the orbit, towards the nose; from thence it passes back again, and is inserted into the middle, betwixt the *Attollens*, which is fixed to the bulbous part, and the ingress of the optic nerve. It moves the eye round, towards the nose, about its axis, and pulls it forwards out of the orbit, and likewise turns the pupil downwards; and thus the eye is disposed to see things placed near it, in the face or nose below it self. The inferior, or lower, oblique muscle rises fleshy from the outward and lower part of the orbit, where the bones are joined together, and is inserted by its tendon, between the *abductor* muscle and the optic nerve:



it turns the eye towards the outward corner, directing the pupil thither; and also upwards, and can draw the whole eye out of the orbit. If these two act together, they fix the eye, fierce and protuberant, out of the orbit, and make it capable of discovering any thing lurking near it. Farther, these muscles suspending the eye, render it very fit to perform the motions of the other four. The soft fat, under the lower hemispherical, convex part of the *Sclerotis*, and betwixt the perforation of the long orbit, thro' which the optic nerve passes, thrusts the muscles from the bulbous part of the eye, and the optic nerve.

But to determine the place and manner of vision, besides the consideration of the structure, all others are to be taken in, which regard optics, catoptrics and dioptrics; and these may best be learnt from Sir *Isaac Newton*, whose sagacity, in mathematics and philosophy, seems to have exceeded the utmost limits of human invention.

Light being an aggregate, or mixture of all colors, every way diffuses its most subtle rays, which yet are compounded of all manner of colors; and may be again divided into simple ones, which being separately, or variously, collected, produce different colors, but, united altogether, make a most splendid light, like that of the sun, or an exceeding white brightness: these rays come from a radiant point, as from a center, towards all other points that lie round it, in right lines, through an homogeneous medium, in the smallest space of time; passing through pellucid bodies, and striking against opaque ones, and so come to every point of the *Cornea*, in a cone; which has the radiant point for its *Apex*, and the plane of the cornea for its *Basis*; if there be no obstacle betwixt the radiant point and the cornea.

These rays, coming near to dense bodies, are bent, some more and some less, and therefore separated; being thus separated and reflected, they afford several colors, falsely ascribed to the reflecting or refracting body, except as they are broke by the force thereof. This reflection, therefore, is various, according to



the variety of colors residing in the rays of light; but yet, in reflection there seems to be the same angle of the reflected and incident ray preserved with the perpendicular, raised from the point of incidence; nor is there any other alteration here perceived.

But, if these rays, pass out of one medium into another, approaching to the latter, they are bent; and so proceed strait through that medium: and as the latter body is more dense; so they pass nearer to the perpendicular, or the contrary; according to the particular latent cause, residing in some fluids, not to be determined without experiments. This inclination is called *Refraction*.

And this, as to sense, is thus constantly performed after; the same ray falling into the same transparent medium, at various angles; as the sines of the angles of incidence are to each other, so will the sines of the angles of refraction be to each other.

And, therefore, the rays, from the radiant and reflecting point, coming to the transparent cornea, are thereby reflected towards the perpendicular, almost by a like change of medium, as in water; and thus pass through the aqueous humor, and are so determined, that they may enter the perforation of the pupilla, upon the superficies of the crystalline humor; but those which enter with so much obliquity, as to fall upon the *Iris*, being reflected from thence, fall out of the eye again, lest, reflecting and entering into the eye, they should render vision indistinct: but others, which fall obliquely betwixt the lower part of the uvea, and vitreous humor, are there stilled in the opake membrane, as if they were not at all admitted; so that none can be transmitted through the vitreous humor, unless such as penetrate the pupilla, and fall upon the crystalline humor. In the mean time, the *Iris* being contracted or dilated, admits more or fewer rays, as the object is more lively or nearer, languid or further off; upon this condition, that the nearer and more luminous the object is, the narrower will be the pupilla, & *vice versa*; and this proceeds from the mechanism, that happens by the

stru-



structure above described, which defends the retina, lest it should be hurt, dried, or scortched.

Therefore, the plainer the figure of the *Cornea* is, the less it refracts the rays which fall from a radiant point, and disperses them the more, so that fewer come to the crystalline humor; and those greatly diverging, unless they proceed from a very remote object; but the rounder its figure is, the more it will unite the rays flowing from a point, and admit the greater number to converge in the crystalline humor. And hence we learn one reason, why persons are pore-blind, and old men dim-sighted.

The crystalline humor, by a new refraction, gathers and conveys the rays received and determined by the pupil; so that those, which rise from one point without the eye, should here again fall through the vitreous humor upon the retina, and be gathered into one point, at a nearer distance, and there paint only that single point precisely, from whence those rays were sent. If the crystalline humor be very thick, or round, then the point of collection will be too near it, and so occasion a confusion in the sight; but if too lax, or smooth, the point will fall too far off, which again creates confusion; and this is another reason, why persons are pore-blind and dim-sighted.

From hence it appears, why those that are mope-eyed are assisted by a concave glass, or by moving the object nearer; and why old men see best with a convex glass, or when the object is placed at a considerable distance.

These defects may also be remedied, by bringing the crystalline humor nearer to the cornea, or by moving it therefrom, which seems performable two ways; *first*, by compressing the bulbous part of the eye, by the four muscles at once strongly contracted; for it would then become longer: or, *secondly*, by contracting the fibres which compress the vitreous humor, and elevate the crystalline. The refraction out of air upon the cornea, is almost equal to that of a ray falling out of air into water; that out of the aqueous humor into the crystalline, is the same as from water



into glass, which is but small; *lastly*, that which arises upon passing out of the crystalline humor, into the vitreous, alters but little, and, perhaps, scarce differs from the vitreous humor, when closely compressed, since that body thus becomes denser; so that the necessity of the vitreous humor seems principally to be, that the crystalline mass might continue capable of moving freely, and so accommodate the eye to different distances; whilst, in the mean time, the mass of the crystalline humor it self is more constant in its figure, than the vitreous.

So that this whole contrivance is the cause, that, in the bottom of the eye, right under the pupil, there should be a distinct and vivid collection of those rays, which, proceeding from one point of an object, and entering into the eye, penetrate the crystalline humor; and that so many points should be painted in the bottom thereof, as were conspicuous in the object; that a small image, like thereto, may be represented on the *Retina*.

For since the mucilaginous pulp of the optic nerve lies exactly in this place, directly under the pupilla and the crystalline mass, it is plain, that this is the part which receives those pictures, and, by a continuation of the impression, carries them to the common sensory, and excites in the mind the idea of the thing seen.

Nay, hence it plainly appears, that the experiments of *Picard* and *Mariot* confirm the same thing, and make not the least against it, as some imagine. And here the infinite wisdom of the creator is to be admired, who hath placed the optic nerve not in the axis of vision, nor towards the external angle of the eye, but in a middle altitude toward the nose.

The perfection of sight, therefore, depends upon that figure, transparency, fabric, virtue of the solids, and that degree of density and clearness of the colorless humors, by means whereof, from every visible point of an object, numberless rays, without mixing with any others, may be gathered into one distinct point of the retina; this focus falling neither too far off, nor too near: and further, upon aptness



aptness of the motion of both, which is capable of painting objects, placed at different distances, distinctly and clearly; for thus magnitude, figure, distance, situation, motion and rest, light and color, are truly represented; and, lastly, in the retina, that situation, expansion, briskness, tenderness, and proportion betwixt the medullary, arterial, venal and lymphatic substance, as may suffer the images of things to pass thro' the optic nerve, remaining in its perfect state, to the common sensory, free and unaltered.

The rays of light do not, therefore, flow out of us, and again reflect into us from the objects, as the *Stoics* assert; nor do we see by any visible species, flowing out of the object into us, as *Pythagoras* would have it; nor yet by emitted effluvia, from the object and the eye, meeting and embracing one another, and at length reflected, as the *Platonists* strangely reasoned; nor, lastly, by a material emanation of corporeal images, as *Epicurus* thought: but vision is mechanically performed, as we have explained it.

From whence it appears, why objects, placed at the least distance which the eye will bear, are distinctly and plainly seen; and why, when farther removed, they are distinctly, but more faintly represented; why, placed too near, they are confused; as also what is required to form distinct, and what to cause strong vision.

To what hath been said we shall add, that though we receive the impression of the images of things, by the reflection of the rays of light into the pupil, as hath been shewn; yet we are to consider farther, that those images, thus represented to the mind, only give us distinguishing marks of the appearance of those things, that we may know one thing distinctly from another, but do not inform us of the nature of them; nor of their essential qualities; color being no inherent quality, but a various refraction from a different superficies; as a rainbow, though only consisting of watry vapors, yet, the rays of light being differently refracted in it, represent different colors, as if it consisted of different substances; so that colors only inform us of a difference



rence in the superficies of bodies, which serves to distinguish one thing from another; because it hath the power to make different refractions; but we hence know nothing farther of the nature of bodies.



## C H A P. XXIII.

*Of the Sense of Hearing.*

**SOUND** is a tremulous motion of the air, arising from a sonorous body that shakes it, by the reciprocal tremor of bodies contiguous to one another. It is propagated from the sounding centre in right lines, towards the circumference of a sphere, as far as the power of it can extend; and proceeds, and is reflected, by those laws, which, in great measure, hold good in the rays of light; only here, the progressive motion is successive, proceeding 968 *English* feet in a second of time; a greater or less sound being equally quick, as it proceeds with or against the wind, but it extends its force further when it goes along with the wind; it communicates its trembling motion to elastic bodies in its way, which those elastic bodies reflect back again without much alteration. Hearing, then, is the perception of a sound excited in the mind, by the help of the organ of hearing.

Hence we understand, that the smooth membrane of the external ear, being anointed in its external cavity with its proper liniment, but endowed scarce with any fat, is stretched upon a thin, elastic, tremulous cartilage, which adheres, by a cartilaginous basis, to the bone of the temples; and, being stretched strongly, reflects the sonorous impressions it receives, without diminishing them.

In the external figure of the ear, there are many things very remarkable; as its considerable eminence raised on each side, upon the *Ossa temporum*; so that scarce any undulating rays can slip beside both ears at the same time; and its three spiral duplicatures, by their form, posture and subordinate inclination, and  
by



by their intorted course and concourse, render them sufficiently commodious, to receive in a due quantity of rays, which are sent from the sonorous point, to one or both ears, which, being reflected unaltered, and united together, are forced into the external concous cavity.

The external opening of this concous cavity, being elastic and free, is furnished with two or three muscles behind, which above are broad, and thin before; by virtue of which it may be made flat, expanded, stretched, and render'd fit to receive those various tremors of the air; and is so disposed, that it can more closely unite, or disperse and scatter, those tremulous rays, and, by that means, temper and diminish a strong, sonorous motion, or increase a weak one, as there is occasion.

The auditory passage consists of a tube, that is partly of a cartilaginous, and partly of a bony substance, and covered with a membrane which grows gradually thinner; being very nervous, and defended with a viscid humor, like wax, which sweats out of the glands, placed underneath; it is most fitly adapted to convey sounds unalter'd towards the inward parts; the obliquity of this tube increases its superficies, and multiplies the places of reflection; a trembling, cartilaginous, triangular tongue standing up in the cavity of the concous aperture, which is chiefly placed above, in the orifice of the *Meatus auditorius*; being furnished with a muscle, that, by a wonderful contrivance, occasions all the undulating rays, directed hither, to be determined into the auditory passage; nor can they fly out again, howsoever reflected. This tube, being of a cylindrical, elliptic figure, ascending and descending with a serpentine course, and rising again, ends in the membrane of the *Tympanum*, increasing the sound and reflection; and making all the tremulous rays, collected together, to run into the middle center of it, without any sensible noise.

The membrane of the *Tympanum*, is furnished with three coats; the middlemost is very full of vessels,



fels, but the outward hath scarce any; it is placed so obliquely, that it inclines towards the upper part of the *Meatus*, and runs out from the lower; and thus, making an obtuse angle above, with the meatus, and an acute one below, it increases the superficies more than if it tended perpendicularly; so that it renders the place larger for the flowing in of more tremulous rays; and thus multiplies their concussions, and occasions them chiefly to run into the centre of this membrane, which make it more easily tremulous; but since the outward, membranous coat rises from the auditory passage, from the inward membrane which encompasses the *Tympanum*, it is evident, that this membrane hath a great commucation, with the internal and external parts of the ear. The middle coat probably rises from the expansion of the nervous membrane.

The strict application here, to the edges of the bony cavity, its thinness, driness and looseness, its hollow figure in respect of the *Meatus auditorius*, and convexity in respect of the *Os petrosum*, and the *Malleus*, being fixed to it, teach us, that this membrane prevents the entrance of the air, from the auditory passage, into the internal ear; that dirt, humors, insects, dust, and the like, are here entangled in the *Cerumen*; and that a titillation being occasioned, especially by the small hairs growing thereon, they are again cast out, that the sonorous motions may be transmitted to the internal parts, and perhaps an obscure kind of hearing performed herein.

The *Malleus* is firmly applied to the membrane of the *Tympanum*, the handle being extended almost to its center; in the mean time, its head is moveable in the bony sinus, and the other superficies of the head, endowed with two small protuberances, and one cavity, is joined by *Ginglymus* with two cavities, and one protuberance, of the body of the *Incus*, which is loosely suspended here, by the artificial insertion of the three muscles into this *Malleus*; here, also, the external muscle, that relaxes the membrane of the *Tympanum*, first appears, which, rising, with a fleshy beginning, out of the upper part of the margin



gin of the external, bony, auditory passage, ends in a tendon; and, running down under the glandulous, waxy membrane, ascends, with its tendon, to the upper part of the membrane of the *Tympanum*, where, passing through the sinus in the edge of the bony ring or circle, it enters into the internal concous cavity, and, descending even to the protuberance of the *Malleus*, betwixt its lower and upper *Apophysis*, it is there inserted; from whence it appears, that it draws the malleus and the membrane of the *Tympanum* towards the auditory *Meatus*, and, by that means, the membrane is made smooth and loose: *Secondly*, here appears an external muscle, which, rising tendinous from the external part of *Eustachius's Meatus*, and lying fleshy upon it, and ascending upwards and backwards, it enters the hollow of the *Tympanum*; and, hid in an oblique sinus, formed above the bony margin of the membrane of the *Tympanum*, inserts it self into the slender apophysis of the *Malleus*; especially that extended into a thin, flexile, elastic, long process, discovered by *Rau*; who taught us, that this muscle is inserted by a broad expansion of fibres, for an extraordinary use, namely, that it might determine and draw the thicker part of the malleus in many different ways, and the membrane of the *Tympanum* towards the auditory meatus: *Thirdly*, here appears *Eustachius's* internal muscle, whose fibres rising from the fore side of the cartilage of his meatus, and then contained in a bony furrow, which is extended laterally to the upper part of that meatus; and, leaving this, its tendon rises up near the oval passage, called *Fenestra ovalis*, and turning back about a bony part, like a pulley, it is inserted into the *Malleus*, on the back part, under the insertion of the external muscle of the *Malleus*; this muscle, contracting, draws it, and the membrane of the *Tympanum*, towards the *Os petrosum*, whereby the membrane is stretched and pressed into a concave figure: from all which we may learn, that the *Malleus* is like a lever, applied to the membrane of the *Tympanum*; and, being moveable in a moment, presses upon the



sinus of the hollowed margin, and, stretched to a fixed basis, sustains its rotation round it, by the help of one, two, or three muscles; it may expand, press back, make convex, or smooth and level, and variously direct, fix, or hold suspended, the membrane of the *Tympanum*, in various degrees, differently directed: *Secondly*, it may, by this means, vary the internal space of the concave cavity, bring the air to it, expel or compress it, as the *Meatus*, described by *Eustachius*, is opened or shut: *Thirdly*, hence the membrane of the tympanum may be adapted to receive the tremulous motions of sound, to be communicated to bodies that are harmonically stretched, and easily impart them to the *Incus*; as the mathematical doctrine of music will teach us.

The body of the *Incus*, articulated with the *Malleus*, pressing likewise against the bony sinus of the *Malleus*; its shorter process being loosely suspended by a ligament, in the upper and hinder cavity of the *Concha*; its longer process fastened to the little orbicular bone; the articulation of this, with the hollow point of the *Stapes*; and the connection of the elliptic basis of the *Stapes*, with the membrane of oval perforation, demonstrate, that the sonorous tremors, being impressed and communicated to the membrane, by the assistance of these four bones, encompassed with their vascular *Periosteum*, and fixed together by their articulations, freely suspended in the great cavity of the *Concha*, and ever moistened with a humor continually supplied for that purpose, may safely, and without detriment, be communicated to the membrane of the oval perforation, and in that condition make an impression upon it.

Again, the *Stapes*, and the membrane of the oval perforation, may be wonderfully stretched, by the muscle of the *Stapes*; which rises fleshy, from a bony canal formed in the *Os petrosum*, at the bottom of the *Tympanum*; and then, descending with a thin tendon, it is tied to the head of the *Stapes*; by drawing obliquely, it depresses one, and lifts up the other opposite part of that membrane.

Thus



Thus sounds are conveyed to the said membrane unaltered; but, as this may be stretched to an infinite variety of degrees, so it may be adapted to receive a great variety of tremulous motions; and thereby concur in the like tremulous motions and vibrations, and communicate the same to the cavity of the labyrinth, which is chiefly shut up and closed by this oval membrane.

The large, internal, conchous cavity, being of a solid, elliptic figure, and communicating with the cellulous cavity of the *Processus mastoideus*, and by *Eustachius's* tube, which is partly bony, and partly cartilaginous, lying open towards the palat, and provided with a cartilaginous, semilunar margin, which may shut it upon occasion; and communicating with the external air, which is drawn by the nostrils or mouth; first allows the air to pass this way into these places, and remain and be rarified there, or go out and be renewed; and, *secondly*, that it may be rendered of the same temper with the external air; *Thirdly*, that the sonorous rays, being admitted by the nostrils or mouth, may enter this way, and supply the deficiency of hearing, when the auditory passage is damaged; and, *fourthly*, because all those places are cloathed with a vascular membrane, to moisten and make them slippery, it serves to purge away the superfluous moisture.

But whilst the round perforation, closed with the thin, extended membrane, lying open into one part of the *Cochlea*, and placed, as it were, in the focus of this elliptic space, opposite to the center of the membrane of the *Tympanum*; it is plain, that those sonorous rays act upon this membrane, the scaly cavity of the *Concha* and its contents, by communicating the tremulous motions of the air; but, perhaps, not so distinctly as those, which are impressed upon the oval perforation, by the assistance of the *Tympanum*, and the little bones before mentioned.

Whether *Eustachius's* meatus, by the help of the internal muscle, is opened at the same time, that the membrane of the tympanum being brought together, the internal cavity of the concha is streightened; and whether



whether its orifice about the palat is closed, with the the cartilaginous valve, by the contraction of the muscle *Cephalopharyngeus*, hindering what is to be swallowed from passing in here, is a question.

But since the oval perforation opens into the cavity, called *Vestibulum*, which is filled, partly with a medullary portion of the nerves, which, from the auditory nerve, entering the perforation in the internal superficies of the *Os petrosum*; and brought down through small perforations into the cavity of the *Vestibulum*, and there distributed and defended by three semicircular, bony canals, through which they pass, and, going out again, appear medullary; and, partly by a medullary portion of a soft nerve, out of the same perforation entering the apex of the *Cochlea*, through many small perforations; and thence distributing little twigs through the upper, spiral cavity; and afterwards a soft, pulpy substance into the *Vestibulum*, under the oval membrane: from all this it is plain, that the sonorous rays, putting this membrane into a tremor, are carried, by the concussion of these nerves, to the common sensory, and there excite and occasion the idea of sound.

But the fabric of the spiral *Cochlea* appears to be most admirable; since the bony canal being also conical, about its bony cone, upwards from its base, makes two perfect spiral turns and a half; and terminates, with its point, at the apex of the cone; being every where, from the basis to the apex, divided into two equally separated parts, by a triangular partition; which partition, on the side near the cone that sustains it, is bony, smooth, tremulous and elastic; on the outward part, in respect of the cone that adds to its firmness, it is membranous and nervous, and is, in some degree, fixed to the fore-mentioned bony part, and again to the bony canal; so that these two little partitions do not at all communicate, but the mouth of the upper opens into the *Vestibulum*, and the lower is closed up with the membrane of the round perforation; whilst these tender nerves, every where distributed, serve to receive the impressions of hearing.

From



From this contrivance it is, that in this place, ending from a determined basis in a point, an infinite number of small, tremulous cords, or vessels, are found, equally stretched; and, therefore, of so great a number, there will always be some, which, with a harmonious consent, will tremble with every sound, and represent it, communicating the same to the common sensory; so that the nice distinction of different sounds, is performed by the assistance of the oval membrane, whilst the round membrane only excites attention, by communicating the preception of a simple buzzing noise, which, at the same time, stretches the bony organs, that they may be fit to distinguish what is heard.

Whether the extreme filaments, or twigs, of these nerves, having done their office, and been distributed thus through all these labyrinths, return again to the brain and common sensory, as *Simoncelli* thinks, and *Mistichelli* hath endeavoured to delineate, is a question; and numberless enquiries must be made before it can be determined.

From hence it may, perhaps, be deduced, why the hearing is quickened by holding the hollow of the hand against the sonorous rays, or tremulous vibrations of the air; and why, on the contrary, the external parts of the ear being cut away, the hearing is duller; why it is brisker, when the ear is exposed to the sound in a plane, at the obliquity of 45 degrees; or, when the mouth is opened and the lower jaw hangs down; or why there is a humming in the ear, and hearing grows duller, if you blow your nose, yawn, speak shrill, or sing; why those that are deaf hear the gnashing of their own teeth, or the noise of a jarring body placed between them; why speaking into the mouth occasions hearing; why the obstruction of *Eustachius's* tube causes deafness; why some, by receiving smoak into their mouths, have it come out of their ears; why the sound is not confused, though received by both ears.

The learned *Boerhaave* here supposes, a person becomes deaf when the membrane of the tympanum is broken; but there appears to have been a mistake as to this fact. That excellent anatomist Mr. *Cheselden* found a dog to hear never the worse for having that membrane crush'd to pieces; and the curious Mr. *St. Andre* knew it lost in a human body, without the least diminution of that faculty.

From what hath been said of the senses, vision and the hearing, as well as of the rest, it appears, how superficial our knowledge is of the nature of bodies by the informa-



tions of our senses; for, as feeling, tasting and smelling only tell us, that different substances variously affect us, and occasion different sensations, without otherwise further satisfying us about them; so we only know they have the power to excite such sensations.

Thus as vision only informs us, that the different superficies of bodies variously reflect the rays of light, and give us a sensation of colors; so hearing only lets us know, that several distinct bodies can give, when moved, a different vibration to the parts of the air, which only shews us that power, without acquainting us any farther with their natures.

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### *Of the Internal Senses.*

#### CHAP. XXIV.

**F**ROM the preceeding discourse of the senses, it appears, that our bodies receive nothing from sensible objects, to cause sensation, but a change in the superficies of the nerve, occasioned by the contract of the object, which is produced by the figure, bulk, hardness and motion of that sensible object varied; 'tis, therefore, probable that all sensible bodies, however different, provided they were the same in these four qualities, would produce the same sensation in the same organ.

But this alone is not sufficient; it is farther required, that the change should be propagated by a free nerve to some place in the medullary part of the brain, and from every single nerve into a particular part of the brain; as we learn from ligatures, wounds and corruptions of the nerves and brain.

But this perception there received is so small and simple, that scarce any thing is more so; and, therefore, can hardly be traced or explained. In the mean time, according to the variety of the object, the difference of the nerve affected, the fabric of the organ of sense, and the distinct part of the brain that nerve comes from; also, according to the various degree of motion, by which the action of the object is applied, a different idea rises, and is perceived by the sensible intellect; and tho' that represents nothing, in the action of the object or in the passion of the organ; yet the same idea always follows the same action, of the same object, on the same organ, so that

the



the connection of these ideas follows the disposition of the said perceiving organ, just as if the idea perceived was the effect of the action of the object on that organ.

Therefore, the difference of these ideas seems not to depend only on that variety, which is in the fabric of every extremity of a nerve, but on a great many other things; though not as causes, but on conditions assigned by the most wise creator.

Ideas most commonly, whilst they are perceived in the mind, excite, by this representation, mirth, sadness, or neither of them; these appearances cause love or hatred of the object which excited that idea; but we are so framed, that this condition of the mind, either of love or hatred, may produce such muscular motions in the body, whereby the objects of joy may be perceived and united to it, or to the thoughts; or by the efficacy whereof an object may be so removed, that sadness, which before attended it shall quite disappear.

But since those muscular motions are exercised by the help of the spirits, drove out of the brain into the muscles, it is plain, that from every point thereof, even to the muscles under the command of the will, there is a free motion of spirits from the brain; so that the common sensory must be part of the brain, where all those points are collected together, and, therefore, it seems to be the *Medulla* of the brain.

So that, the more distinct and lively the action of the object is upon the common sensory, so much the more bright and determined will be the idea rising from it; the oftener the action is repeated, the clearer also must be the idea; and the more remote the action of the object is from all others, and the more unusual, the brisker.

If, therefore, the condition, imprinted upon the common sensory, be so firmly fixed therein, that, by the supervention of other actions it cannot be changed, the present idea must remain the attendant of that condition; or, at least, by means of some like cause or similar idea, the same idea is return'd, either in obedience, or contrary to the will; which, being attended with a consciousness of the like, formerly perceived, is called memory.

But all this only depends on the simple condition of the common sensory, which is there only a meer mechanical disposition; and, therefore, it may easily arise from



corporeal causes in the body, wheresoever they lie hid, affecting the nerves, spirits and brain after such a manner, as to excite the same ideas, as when they proceed from external, corporeal causes: and this disposition is called the primary imagination.

If, then, there be a strong remembrance of the like idea, stirred up by means of an external object, that acted formerly; and, at the same time, the present idea, now depending upon an internal disposition be lively, a strong persuasion arises, that the cause of this now present is without the body, which is a secondary imagination.

If the will in the common sensory, and the parts strongly cohering with it, retains that state, which rises from the action of a distinct and lively object; or if the actions of all other objects are prevented, and only the former retain'd, this action is called attention; by the exertion of which an idea is made distinct, clear, vivid and lasting; which, therefore, is the parent of knowledge; being the best way to attain it.

From whence we have a knowledge of the five external senses, as well as of the internal, called the memory, imagination, affections of the mind, and attention; to which some add hunger and thirst. From hence also we understand a great many questions, that are asked about this matter; as, why, corporeal signs, which wholly depend upon the will of the maker, so greatly affect, direct and change ideas? why it is impossible to alter a secondary imagination by any reasoning, but only by violence? why *Ceteris paribus*, the external and internal senses are vigorous, when voluntary, muscular motion ceases? why attention, memory and imagination stupify the external senses, and suppress the motions of the body? and why these lie neglected when the other actions are vigorous? why the body grows weak, by a vigorous and long continued action of the mind? and why the frequent change of subjects makes the mind chearful? why meat, drink and medicines, poisons, rest, motion, air, heat, cold, custom, and passions of the mind have so great a power in all these cases? upon what condition of the body the judgment either affirmative or negative, reasoning and the regular method of thinking, depend? and, lastly, why a distinction is sometimes so prevalent, and the secondary imagination detrimental?





## C H A P. XXV.

## Of Sleep and Watching.

**H**E is said to be awake, whose external and internal organs of the senses, as also the instruments of voluntary motion, are in such a state, as easily to perform their accustom'd office, and be readily affected by objects. This wholly depends upon the presence of good spirits, in a due quantity in the brain, its *Medulla*, the nerves and muscles; as also upon a good condition of the solid parts that constitute the same: so that watching is that state of body in which these two conditions are to be found.

But the notion of sleep, was ever looked upon as the most obscure, though it be only the opposite state to waking; therefore, to know its nature, we are to consider all the phenomena which attend it; and those are as follow.

One, that from waking, begins to fall into sleep, gradually grows dull, and all the senses, both external and internal, are exercised with more difficulty, and a seeming weight or heaviness of the whole body attends, till at last they altogether cease. As they are gradually retarded or lessen'd, with a sense of resistance, at length too all the voluntary motions stop; the muscles designed to perform them, grow flaccid, and paralytic; first in the eye-lids, face, neck and arms; and by degrees over the whole body; and all the actions both of mind and body cease,



In the mean while, the motion of the heart, arteries, and veins, is stronger, slower, more equal and full, increasing by degrees as sleep increases. Respiration grows deeper, stronger, slower and more equal by degrees, as sleep comes on; and therefore, the actions that depend upon these, are more perfectly performed; the blood more commodiously circulated, and digested; and secretion, perspiration, and the distribution of nourishment, more successfully carry'd on; the humors circulating quicker through the blood-vessels, and the parts near the heart; but slower through the sides of the body, and the remote parts, as well as the muscles.

A person wakes from sleep, if any external object violently affects the sensory; thro' the sensation of any inconvenience from the stimulation of an excrement; or an uneasiness from the compression of any part lain upon; but sometimes spontaneously. The longer sleep is continued, the more is drowsiness increased, so that *ceteris paribus*, a man's life may be wholly spent herein.

When a person wakes, the parts first seem to be convulsively moved; the eye-lids open; the limbs are stretch'd; he yawns; gradually grows sensible, and fit for motion; and his strength being renew'd, he is in perfect vigor.

Sleep is occasion'd, promoted, and increased, by eating gross meat, or too great quantities, and by its remaining long in the stomach; by drinking plentifully, especially of spirituous liquors, or such as are aromatic and fragrant, as saffron, clary, sage, and the like, which yet are not acrimonious; by the milk of poppies, the juice of hounds-tongue, or wild lettuce, mandrake apples, or the juice of nightshade.

It is also encouraged by much, or long continued labor; a quiet disposition of the mind; a body  
free



free from motion, and unaffected by external objects: also, by excess of heat or cold; whether from any common cause, the heat of summer, or temper of the body; and by all such causes as hinder the protrusion of the blood into the cortex of the brain, or its passage through its vessels, and the necessary separation of spirits; the derivation of them into the nerves, the organs of sense, and the muscles severing to voluntary motion; and the reflux of them towards the common sensory: again, by too large evacuations, a phlegmy indisposition of the blood, or fatness, clogging the humors inwardly, or a *Plethora* crowding them; wounds, phlegmons, and impostumes of the brain; extravasation of the humors under the skull, a contusion of the brain, its compression, abscision, or putrefaction; if the *Cerebellum* be unhurt, and rightly perform its office, all such accidents occasion sleep.

It is hindered by a perpetual mixture of watry, or hot liquors with the blood, or any thing sharp that twings the nerves of the brain; also by violent passions of the mind, or the brain's being disturbed by any internal or external cause.

And therefore sleep, is such a state of the brain, wherein the nerves do not receive from thence so large, nor so strong an influx of spirits, as is required for the organs of sense and voluntary motions, to perform their actions with ease and quickness.

The most immediate cause hereof is, perhaps, the defect of a subtle spirit, which requires a long time to prepare it, and which is now spent and exhausted; so that the finest vessels being emptied and flagged, for a time, fall together; or there is too great a flux of thicker blood to the cortex of the brain, so that the medullary part is compres-



fed, and the motion of the spirits hindered; and the natural cause of sleep is every thing that may produce these two particulars.

From hence, the effects of it may be understood; for some actions cease in sleep, and their organs are at rest as well as the muscles, through which the spirits, scarce any longer flow; therefore, there is less expence of them, and the solid fibres of the nerves and muscles, are scarce changed or destroyed; there being an equilibrium in all the parts, no variety of pressure in the vessels, nor any variety of velocity in the humors.

But in sleep, the motion of the heart, lungs, arteries and viscera, are increased; nor is there any change or destruction by the action of the senses, or voluntary motions, which then cease; and therefore, those effects are produced, which immediately depend hereon; and may be, *first*, the stronger and more equal circulation of the vital humors, through the vessels that are then more free, loose, and open to receive them, being not obstructed by a variety of muscles; for which reason, the impulse into the lateral vessels is less, but more equal, and through the large vessels, stronger and more equal; and thus, by degrees, the lateral vessels are replenished, the humors flowing more slowly through them; and, at last, they and their humors are almost without motion: then the little lateral oily bags are filled with thicker matter, and distended, as well as those in the glands; so that, at the last, circulation is only continued through the blood-vessels; growing gradually slower, and at length scarce perceivable, if continued too long in that state. In the meantime, the fat that was gathered together, being dispersed about like balsam, defends the parts within contained, and affords some slow recruit, as necessity requires. *Secondly*, then, in moderate sleep, the



the chile is conveniently changed into serum; this into thinner humors; and those into nourishment.

*Thirdly*, there is a detrition of the solid parts which cohere not firmly together, that grows by degrees more gentle. *Fourthly*, there is a great discharge through the skin; the others being decreased.

*Fifthly*, this is the best time for nourishment, and renewing what was destroyed; for an equal, continual, good repletion restores the humors; and the solid parts are then best repaired, because the causes that hindered this are at rest; and, in the mean time, the matter is best prepared, there being an aptitude in the vessels to receive it, and in the humors to enter into them; the causes which apply and consolidate acting freely. *Sixthly*, hence, a new production and accumulation of animal spirits is made in all the humors, as to the matter, and in the least vessels, in respect of repletion.

All which being thus refreshed by sleep, there will be again an aptitude in the body to wake, and the contrary to sleep; so that an exciting cause returning, a man presently awakes.

From hence we may learn, why a person cannot sleep with his head hot, and his feet cold; why spirituous liquors first cause drunkenness, and then sleep; whence dreams and motions in sleep proceed; why, after eight hours sleep, perspiration is double the quantity it was in the same time when awake; why too much sleep makes the head heavy, the senses dull, the memory weak, the body cold, phlegmatic, fat and heavy; why it suffocates the strength, renders the muscles unapt for motion, and hinders perspiration; why he that sleeps much may continue long without food; why after a sound sleep there is an expansion of all the muscles, frequent yawning, sharpness in judgment, agility in the muscles and nerves. It hence also appears, why a fetus always sleeps;



boys often, and youths more than grown men, or old ones; and, lastly, to what end a man recovering from a violent disease sleeps longer, than when he is in perfect health.

But the reason why, in sleep, the muscles of the heart are not flaccid and paralytic, as others, nay, on the contrary, why they act stronger, seems evident, if we consider, *first*, the difference of the soft part of the brain, which is furnished with cavities, and pressed and encompassed with venous sinus's, that may alter its dimensions, so that it may expand and be compressed; it is also enclosed in large external arterial plexus's: and if we, moreover, consider the difference of the *Cerebellum*, which is more solid and compact, without any cavities, and neither encompassed nor pressed upon with venous sinus's, and not subject to be expanded or pressed, but only furnished with veins and arteries, as other parts are. *Secondly*, That the cardiac nerves owe their origin wholly to the *Cerebellum*. *Thirdly*, That the coronary arteries are filled and emptied at different times, from those in the rest of the body; and the veins likewise. *Fourthly*, That the cavities of the heart are filled at the same time with the coronaries. *Fifthly*, That the auricles and cavities of the heart are filled, emptied, and act and rest alternately, and successively by turns. From all this, I say, it will appear, that the causes of the contraction of the heart continually renew, act, and cease: and, perhaps, the vital spirits of the *Cerebellum* may be thicker, than those of the *Cerebrum*.





## C H A P. XXVI.

## Of Respiration.

W H A T respiration is, and why it constantly continues without the assistance of the mind, will appear from what follows. No action, indeed, is more apparent and frequent than this, yet it is hard to be understood ; being partly involuntary, and partly voluntary, whilst abundance of organs are concerned in performing of it. We are, therefore, carefully to enquire into the means thereof, by considering its phenomena and organs.

The lungs being suspended in the open air, that every way flows to them, and every where presses equally upon them, continually contract themselves into less compass, than whilst they continued in the cavity of the thorax. This contractive power is chiefly owing to the muscular fibres, which tie together the squamous parts of the *Bronchia*.

The lungs, thus contracted, and filled with air, thrust in with force through the glottis, are so distended as to possess an equal, or even a much greater space, than that assign'd them in the thorax : the same thing also happens, if, whilst the air passes through the glottis into them, the external pressure be diminish'd, as we see in the air-pump.



From whence it is plain, that the lungs, by their proper force, always endeavour to possess less space, than they do, whilst contained in the cavity of the thorax; and that they are always in a state of contraction, whilst a man is living; and therefore would fall together and contract, were the whole body contained in an exhausted receiver.

For it is not common air about them, betwixt the external membrane of the lungs and the *Pleura*, that compresses them on every side, whilst life continues: nothing, therefore, does compress them externally but the diaphragm; yet air is always contained within them, and passes freely thereinto through the glottis; therefore the lungs are always distended by the internal air somewhat more, than they are compressed by the external, which is hinder'd by the diaphragm, so fixed to the ribs and the *Vertebrae* of the back, that it cannot enter the thorax to occasion an equilibrium.

This is evident from anatomy; the growth and increase of a fetus in the womb, and of a man; the lungs when blown; wounds penetrating into the cavity of the thorax, causing the lungs to collapse, and hindering them from dilating, sometimes on one, and sometimes on both sides of the thorax; but especially Dr. *Hook's* famous experiment upon live dogs demonstrates it.

Since then, in inspiration, the air enters the lungs in a greater quantity, than before, this must extend them the more, and oppose their natural constitution, in which action the lungs are passive; and what is the consequence hereof appears from the phenomena.

In inspiration observed when a man is asleep,  
*First*, The nine upper ribs, articulated to the *Vertebrae*, and adhering to the *Sternum* by their cartilages,



tilages, rise archwise towards the clavicles, so, that this motion is chiefly observed in the middle of the arch; but the three, or perhaps four lower, are at the same time turned downwards and backwards obliquely, but so that the seventh, eighth, ninth and tenth, with their cartilaginous parts, are drawn, as it were, inwards. *Secondly*, At the same time, the whole abdomen swells more and more, during all the time of inspiration, and is pressed outwards. *Thirdly*, At the same instant, the capacity of the thorax is enlarged, which appears both to the eye, by measuring it, and by the mechanical consideration of its figure, situation, connection, and articulation of the ribs, as *Bozzelli* hath demonstrated.

In this action, the diaphragm, from its convex and sinuous position, is brought downwards into a more plain figure; and this appears from incisions made in living brutes, and large wounds in the abdomen in men; which change of figure depends on the musculous fabric of the diaphragm, as appears by its structure.

Since, then, in inspiration there are no other visible actions, the cause of it must be determin'd by the motion of the ribs and diaphragm, the reason of whose motions are to be inquired into.

The upper ribs are arched and bent, and much more depressed in the middle than at their extremities, being articulated by two apophyses, covered with a cartilage. *First*, In the cartilaginous cavity of the *Vertebræ*, being united backwards and laterally, or in the body only of the first vertebra. *Secondly*, In the cartilaginous sinus of the transverse process of the *Vertebræ*, the seven upper ribs are joined to the *Sternum*, by the interposition of an arched cartilage, very elastic, in an acute angle upwards in the first rib; the second almost



almost at right angles; the other five at obtuse ones: so that the angle here, made by the cartilage of the ribs with the sternum upwards, is the more obtuse, the lower the rib; or else that cartilaginous segment ascending, thence enters the lateral cavities of the *Sternum*; so that the higher the rib, the less the angle of this insertion, from the concurrence of the upper part of the sternum. *Thirdly*, The sixth, seventh and eighth ribs join their cartilaginous arches in the cavities of the *Sternum*, uniting with their extremities, which appear in the lower part of the sternum, and grow together amongst themselves; their broad cartilaginous processes uniting one with another. The two lower ribs, and sometimes three, having one apophysis backwards, are articulated only into one sinus in the body of one of the *Vertebrae*; and their cartilages, almost growing tendinous, do not touch the *Sternum*, but, being inserted into the diaphragm, and the cartilages of the ribs adjoining, disappear; they seem to direct, equally sustain, move backwards and downwards, and so assist in the motions of the diaphragm.

The external intercostal muscles, rising from the lower margin of the upper rib, descend obliquely forwards, and are inserted into the upper margin of the rib below, throughout the whole bony verge, betwixt all the true and bastard ribs: but the internal, rising from the lower margin of the upper rib, at a distance from the sides of the spine of the thorax, descend obliquely backwards, cross the others, and are inserted into the upper margin of the rib below the following, all the length of the bone.

Besides, the subclavian muscle, rising fleshy from the half and lower part of the clavicle, where it is joined to the spine of the *Scapula*, and proceeding ob-



obliquely forwards, is inserted in the upper margin of the first rib near the *Sternum*.

If, therefore, these muscles are contracted together, then the first rib is fixed, already firm by its proper articulation, by the force of the subclavian, and the nine following ribs are lifted upwards, and turned outwards, especially in the middle of the arches, yet so as to retain their equable parrallelism, whilst they depress the cartilaginous segments which resist them, and thus the cavity of the thorax is enlarged.

The diaphragm contracted, becomes plain, and dilates the thorax, but compresses the abdomen, and draws the foremost cartilages of the bastard-ribs, internally towards the *Vertebræ*, and the two lower bastard ribs; and also distends and overpowers the muscles of the abdomen.

And these muscles seem chiefly to be concerned in inspiration; the intercostal receiving nerves from the spiral marrow, and the diaphragm from the diaphragmatic, vertebral and intercostal nerves.

The capacity of the thorax being thus enlarged, betwixt the *Pleura* and the superficies of the lungs, nothing presses upon the lungs, and therefore the air, entering through the *Glottis*, fills them, till they are contiguous to the pleura and diaphragm.

In this case the air presses the lungs equally, and the thorax resists it, and so, the lungs being at rest, the blood passes less freely, and is forced into the left ventricle of the heart in a less quantity; and so less comes into the *Cerebellum* and its nerves, and the arterial blood acts less upon the intercostal muscles and the diaphragm: the causes, therefore, that dilate the thorax grow weaker, and the elastic segments, which are cartilaginous, again depress the ribs, the muscular fibres, which rise  
from



from the side of the sternum within the thorax, and from the bony end, assisting them; as also those inserted into the cartilages of the true ribs; and at the same time, the distended fibres of the peritoneum and muscles of the abdomen restore themselves; and the viscera thus pressed, thrust the diaphragm, which is now loose, upwards again into the thorax; and, that contracted, the air is drove out of the lungs, which is called expiration: and thus, by these two actions, the blood is propelled and quickned in its passage thro' the lungs. At this instant, the blood being quickned in its motion, begins to flow stronger, and more plentifully to the cerebellum and muscles; and the intercostal muscles and diaphragm renew again the causes of contraction, and inspiration is repeated: and thus these alternate motions are continued.

But, besides these causes of respiration, there are others subservient to the will, which are also applied to the ribs, for the violent dilating or contracting of the breast. The former, tho' design'd for other purposes, yet also serve for this: *first*, the muscle called *Scalenus*, rising from the fore part of the transverse process of the second, third and fourth *Vertebræ* of the neck, and, descending obliquely forwards, is inserted by its tendon into the first rib. Then another, called also *Scalenus*, rising fleshy from the side of the transverse process of the second, third and fourth *Vertebræ* of the neck, descending and growing tendinous, and passing over the first, is inserted into the second, and sometimes also into the third rib. Then the third *Scalenus*, rising also carnosus from the lateral and fore part of the transverse process of the *Vertebræ* of the second, third, fourth, fifth and sixth *Vertebræ* of the neck, is inserted, for the most part, into the first. These lift up the three upper ribs, lest the force of the inter-



intercostals and others should, in strong inspiration, be determined downwards; nor may they be unserviceable in bending the neck, or turning it about; because, if they act together, and the neck, by the muscles that keep it erect, as the *Spinalis*, the *Transversalis* and *Interspinalis*, the *Longissimus Dorsi* and *Semispinatus* acting together, be held firmly, the action of the *Scaleni* must needs lift up the ribs; but, in the most violent respiration, it is certain, that a great many such actions conspire. *Fourthly*, The lesser *Serratus anticus*, rising fleshy from the *Coracoides* process of the *Scapula*, descends obliquely forwards, and, growing larger, thinner and fleshy, is inserted into the fore part of the second, third, fourth and fifth ribs. *Fifthly*, The *Serratus anticus major*, rising fleshy from the basis of the *Scapula*, large and thick, and descending obliquely forwards, is inserted into the eight upper ribs, by fleshy portions, like the teeth of a saw, two or three, or four or five of the lowest of which, are inserted betwixt the like processes of the external oblique muscles of the abdomen. And if the muscles of the *Scapula*, as the *Trapezius*, *Rhomboides* and *Levator*, hold it fast upwards and backwards, then the action of both the *Serrati* strongly lift up the ribs from the second to the eighth, which plainly appears in violent breathing. *Sixthly*, On the back part, the upper *Serratus posticus*, rising tendinous from the spines of the two lower *Vertebrae* of the neck, and the three upper of the thorax, it is inserted with fleshy teeth into the bending of the second, third and fourth ribs, and lifts them obliquely upwards. *Seventhly*, The lower *Serratus posticus*, which rises from the spines of the *Vertebrae* of the loins, and sometimes from some belonging to the thorax, is inserted with fibres, like fingers, into the middle of the arch of the ninth, tenth and eleventh ribs, and



and the end of the twelfth; this, from a course almost horizontal, ascending upwards, and pulling these last ribs outwards, downwards and backwards, enlarges the thorax, and hinders the contracted fibres of the diaphragm from bringing these ribs together, to streighten the cavity thereof.

But the action of the oblique external and inferior muscles, and the *Recti* conspiring together, pressing down the ribs, and contracting the *Thorax*; and the lower *Serratus anticus* resisting, as its connection shews, if it concurs with the *Sacro-lumbalis*, which is very much compounded, and scarce distinctly to be described, consisting of a series of fleshy fibres, rising from the transverse ones of the *Vertebræ* of the loins, and their spines, ascending upwards to the ribs, and joined with the fleshy accessory muscles proceeding from them: this action must strongly assist in violent expiration; the abdomen being also contracted by its transverse muscles.

In women the sternum is more compressed, the clavicles straiter, the thorax narrower, and smaller before; and the cartilaginous segments sooner grow bony above than below: therefore, when they draw in their breath, the sternum is turned upwards, and obliquely outwards, and the whole thorax seems to rise; for which reason they breathe the easier when their belly is distended.

Hence it appears, that the muscles, which serve to respiration and voluntary motions, are much bigger and stronger, than those which only serve for involuntary respiration; for which reason the first can increase, diminish, or wholly stop either of the actions of respiration: from whence it happens, that there are not two succeeding moments of life, in which the vessels of the lungs have the same figure, capacity and action.



It may be also observed, that there are some muscles here that act without antagonists, as if they had them; and therefore the action of the fluids, moving these muscles, must be an antagonist to the simple spring of the resisting solid.

There is no need then, to suppose alternate actions of humors to cause alternate motions, and reciprocal actions in both parts; it is sufficient, if the same happens in either: we see the voluntary power can stop the force and cause of respiration, but the force of the heart it cannot stop; therefore the cause of the motion of the heart is stronger and more constant, and its action more frequent; yet there is a certain consent, betwixt the pulsations of the heart, and the number of respirations; but according to what rule is a question.

Hence, also, we perceive the necessity of repeated pulsations of the heart, and of repeated respirations: but if they be stopped long, life must certainly cease.

We see farther, why, in an asthmatic fit, a *Peripneumonia*, difficulty of breathing, or the agony of death, respiration is performed by the involuntary and voluntary muscles, strongly concurring to the same action; so that the neck, *Scapula*, breast, lower ribs and back are evidently moved; why, in perfect health, when the body is quiet and awake, respiration is so slow and gentle, that it can scarce be perceived; and yet there remains a brisk circulation of the humors: to conclude, it hence appears, why, upon coughing, quick breathing or sighing, the motion of the blood is quickned through all the vessels; why the first action of the respiration is inspiration; why, when people are dying, and the breath long stop'd, the venous sinus's, the auricles, and the



the heart beat; and how it happens, that to continue breathing and life, such air is altogether unfit, as, in an extreme degree, is heavy, light, moist, dry, hot or cold, too much compressed or rarified; and also, that which, when included in a small space, is not soon enough renewed.



## C H A P. XXVII.

*Of the Voice, Speech, Singing, Laughing, Coughing, &c.*

**F**ROM what hath been already deliver'd, we may clearly conceive, how the voice is form'd; for this sound is made in expiration, and consequently by the expulsion of air, contained in the whole cavity of the lungs, by those causes that contract the thorax, through the *Aspera Arteria*, and the foremost cavities that are of a bell-figure: from thence it is forced into the *Glottis*, where, the passage being narrower, the motion is the quicker, and, being forced upon an elastic or springy tremulous body, 'tis, by that means, put into reciprocal waving motions, and forms a sound; which coming thro' the narrow passage of the glottis, into the cavities of the membranous substance of the mouth and nostrils, as these cavernous parts are more slippery, rough, open, obstructed, or differently figured, the sound becomes various, and passes differently out of the mouth.

But



But since the cartilaginous fides, called *Arytænoides*, joining to the smooth heads of the cartilage *Cricoides*, by means of their sinus's; and, being made slippery by their own unctuous liniment, form a small chink by their union, and can open or shut it, according to the various actions of the muscles placed here; and from hence proceeds the different shrillness or dullness of the voice; for all that depends upon the quick or slow repercussion of the undulating air: it is here made quicker as the passage is narrower, or as the air is drove out with the quicker motion; but, a grave voice is the effect of a slower motion, or undulation of the air, out of a larger chink.

From whence it appears, that when this chink is too much opened, by those that endeavour to speak with a greater voice than they are able, the sound is lost; and there is the same loss of sound, in forming a too acute voice; the air retained causing a sort of suffocation of the lungs, and a harsh shrillness in the *Larynx*.

If this sound strikes against the organs placed without the larynx, (as the throat, tongue, teeth, lips, nostrils, the membranous or musculous palate, which vary much in their respective union and position) it is by that means changed in its passage, or reverberated, and variously determined; and this is that which is expressed by letters: as the origin of which, and their combination to form speech, see *Johannes Conradus Amman*, in his *Surdus loquens*, a man of wonderful success and industry in this matter.

But since singing is to utter sounds, either grave, acute or sharp, quick or slow, strong or soft, equally or unequally, this action appears from what hath been said; whose graces depend on the voice, tone, time and manner of turning



it : a slippery superficies in the organs occasions a sweetness of voice ; as also, the conformation and figure of the throat, mouth, palat and nostrils.

The agility of the muscles that move the glottis ; the looseness of the ligaments which join the cartilages of the larynx ; the different magnitudes the fabric of the glottis admits of in its opening ; the copiousness of the oily juice of the great gland *Thyroides*, especially by the assistance of the muscles *Sternohyoideus* and *Sternothyroideus*, that lie upon it and press it out ; these seem to give the faculty of forming a variety of sounds distinct and plain : the form of the lungs and thorax, which supply breath for sounds, is the chief cause of the strength and length of the voice ; but the art of singing depends on an artificial turning and moving all these parts.

Laughter is produced by an undulating motion of the air, received into the dilated lungs, and the *Aspera Arteria*, without renewal, which occasions very small, quick and reciprocal concussions of it, in passing thro' the organs made for respiration ; the lungs almost remaining in the same degree of tension, and jumbling the blood together, rather than discharging it : whence it appears why laughter is so fatiguing, and often ends in convulsions ; and why it occasions a tumor of the jugular veins, and consequently of the whole head, and a redness of the face, neck and eyes ; and sometimes a difficulty of breathing, spitting of blood, an apoplexy, and death, if too violent and long continued.

From hence also, the reason of coughing appears ; it arising from a great quantity of air drawn into the lungs, and retained a while ; upon which the larynx being shut, and the diaphragm thrust into the cavity of the thorax, by the muscles of the abdomen, which condenses the  
air,



air, and presses much upon the sides of the lungs; and then, the larynx being opened again, it is variously shook, by several, successive, violent protrusions in expiration, which cleanses the internal superficies of the wind-pipe: this shews why laughter often ends in coughing, and how little difference there is betwixt these two actions; also, why loud singing, bawling, sharp things, or crudities, upon the membrane of the *Bronchia*, occasions it: from hence also, appears the reason of sneezing, before explained.

Yawning is produced, by expanding almost all the voluntary muscles, and very much extending the lungs, the breath being drawn in gently and slowly; and, having been retained and rarified a while, it is then gently and slowly breathed out again; when the muscles are restored to their natural state: the effect of it is, to move, quicken, and equally distribute all the humors through their vessels, and thus it makes the organs of sense, and the muscles fit to perform their office; every part being moved at the same time by its proper organs: but, for a more particular account of these various motions, see *Fabricius ab Aquapendente*, *Borelli* and *Eustachius*.

Having thus far, by means of mechanic causes and organs, explained those vital, natural and animal actions, which are common to both sexes when grown up; we shall next consider those that are proper to each sex, in regard to generation; which also greatly differ in different persons of the same sex.





## C H A P. XXVIII.

*Of the Origin and Nature of the Male-Seed, &c.*

THE seminal arteries, rising from the fore part of the *Aorta*, below the emulgents that go to the kidneys, almost constantly observe that rule, but sometimes the left rises out of the emulgent artery; they are not large, and, by reason of their oblique course from the aorta, contain but very little humor; their descent is oblique, and the spermatic veins take the like course; the right of which rises from the *Vena cava*, under that which goes to the kidneys, the left springing from the emulgent vein, but frequently after a different manner, being joined at an acute angle: these are included in a common membrane, and closely united together, descend safely under the inner coat of the *Peritonæum*, upon the *Psoas* muscles and the ureters, till they come to pass out of the abdomen in the groin; where they lie upon the fleshy fibres of the transverse muscles, and the lower oblique ones; which parting a little from one another, they admit these vessels thro' them included in their membranous case; so that the place thro' which they pass is the uppermost part of the transverse muscle, and again, in the obliquely ascending one below it; from whence they proceed through an oval ring, in the tendinous part of the obliquely descend-



descending muscle, three lines lower than the former: lastly, this case, with its vessels, descends upon the *Os Pubis*, and, being brought down into the *Scrotum*, composes the testicle it self; where the cremaster muscle grows about it, which rises fleshy from the lower, larger and fore part of the spine of the *Os Ilium*; growing, in its oblique descent with fleshy fibres, to the fore and descending margin of the *Os Ilium*, towards the *Os Pubis*; from whence it expands it self forwards, obliquely downwards, and embraces the sides and fore part of the *Tunica vaginalis*; whilst fleshy fibres, rising from the fore part of the *Os Pubis*, behind the membranous case, directly tending downwards, are fixed to the membrane on the back part; and so form a hollow muscle, which lifts up, sustains and compresses, as well as forces, out the membranous cover and the testicle; and, in all this passage, it sends forth small twigs of arteries laterally; besides, the three places in the muscles, which transmit this membranous case, furnish it likewise with a thin, small membrane; but when the veins come near the testicles, they form the pyramidal body.

In this course, the spermatic artery, being bent spirally, distributes small branches, which, with a strait open course, send blood laterally, by anastomosis, into the vein that attends it; especially in the pyramidal body, where the femoral artery, near the testicle, gives a branch to the lower and inward part of the *Epididymes*, which, affording some twigs to it, are inserted into the nervous coat; and sometimes another branch is inserted into the top of the testicle; but a large branch is always inserted into the upper and greater part of the epididymes, being distributed thro' the vessels thereof and every where dispersed therein; besides



many branches from the greater venal trunk are intimately interwoven in the pyramidal body, and, communicating with one another, distributed throughout the circumference of the testicle.

For, the pyramidal body, called *Corpus varicosum*, or *pampiniforme*, rising from the back of the testicle, consists of a great many veins, communicating one with another, and, forming a sort of net-work, which at last end in one seminal vessel; where there is a very commodious opportunity for the blood to pass into the veins.

Those arteries which penetrate the nervous coat, being gradually divided into branches, and placed distinctly, are at last subdivided into a vast number of small capillary vessels, and distributed through the whole testicle; and, perhaps, being united again with the large vessels, end in that great one, which passes through the middle of the testes, and is continued to the *Epididymes*, discharge their liquor at innumerable extremities; whence they have no veins, but end in the emissary vessels.

And those vessels, ending in the epididymes, discharge their humor into the cavity thereof; which is one continued, hollow, cylindrical vessel, complicated into innumerable flexures; and, lying upon the body of the testicle, stocked with arteries, and ending in one vessel, called ejaculatory; this, rising up again above the *Os Pubis*, and descending into the *Pelvis*, and coming near the back part of the neck of the bladder, ends there in seminal bladders. This structure is carried on with nerves, from the fine nervous net of the abdomen, along with the spermatic vessels, being distributed thro' the nervous coat, where they vanish from the sight: they also receive others from the twenty first spinal pair.



Very small veins, and abundance of lymphatic vessels, bring back that humor which remains after the separation of the seed; and it is probable, that in these vessels where it is made, and not yet discharged, a great part, and that too very subtle, may be received again thereby, and mixed with the venous blood in the pyramidal body, which will make an alteration in the whole constitution and disposition of the body.

The *Vesicula seminales*, being fastened to the back part of the neck of the bladder by membranes, are, like so many small blind guts, complicated and folded together in wreaths and recesses, in which the ejaculatory vessel terminates, gradually broader and full of sinus's; but grows narrower again, where it enters with a bend, and ends in these small gut-like vessels, almost in a right line, very large towards the bottom of them; from whence every small vessel is endowed with another little emissary, joined with the former at acute angles; which two emissaries, joining at obtuse ones in the urethra, end there in one open excretory duct: in the mean while, these two emissary bladders are bound together with a musculous membrane.

From all which it appears, that blood, like what goes to the kidneys, being received in a small quantity by the spermatic artery, moving slowly, being retarded about the pyramidal body, and deprived of the thicker red part, by canals opening into the veins, and by that means becoming less red, and more slow in its motion, so as almost to stagnate in the recesses of the testicles, where it is found of a grey color; and, becoming thicker and more concocted in *Highmore's* ducts, 'tis slowly drove into the epididymes, and further digested by the complication and involution thereof; here, being almost stagnant, and



well elaborated, it at last creeps into the ejaculatory vessel; which at first is of a thick and spongy substance, and narrow, but becomes broader, then very large and sinuous, but afterwards, narrower again; this humor there collected in its dilated sinuous recesses, where it remains and is again digested and elaborated, and then forced into, laid up and preserved in the twisting sinus's of the seminal bladders, where growing thicker and whiter, and being still further digested to the highest degree of perfection, it is called seed.

Whence it appears, that no humor is prepared more slowly, so much stopped by the way, or so greatly digested when at rest; and perhaps, something may all along be added to it, from the small nervous twigs, in its passage; whilst the thinnest humor is drawn off, by the lymphatic vessels into the veins, in the pyramidal body, or the veins from the seminal bladders, and thence returned to the whole mass of humors: both these seem very probable.

The humor that is found in the middle of the testicles, in the *Epididymes*, and ejaculatory vessels, as well as the seminal bladders, being fresh, diluted with a little warm water, and then viewed with a good microscope, appears to consist of a vast many small, oblong, living animals, with tails like little snakes, swimming up and down therein: this is found true, not only in men, but in beasts, birds, fish, amphibious creatures and insects; but only in the humor of the said part. If these be compared with the bulk, figure, place and changes, of what is observed by *Malpighi* in a chick; and with the method of nature in the generation of frogs, it will appear probable, that these *Animalcula*, in the male-seed, contain the rudiments of a future human body; especially, since the testicles, or this humor, being wanting, the person becomes



becomes fruitless : but more of this, when we consider the reason of conception.

In the same place, where the passage from the seminal bladders open into the *Urethra*, a gland grows about it, called *Prostata*, being single, of a continued substance and conical, encompassed about with muscular fibres, and composed of twelve distinct clusters of glands ; so that the glands of each cluster, by proper emissaries, end in one vessel, whereinto they pour their liquor ; there are, therefore, twelve distinct vessels or bladders, and so many distinct excretory ducts, which open into the cavity of the *Urethra*, so that they surround that passage of the seminal bladders ; the seed, and the liquor from the *Prostata*, by that means, being perfectly mixed together, whilst the *Vesiculae* and the *Prostata* are both encompassed with the same muscular membrane.

The humor prepared here is soft, fat, white, and large in quantity ; 'tis often, after long abstinence from venery, pressed out upon making water, or going to stool : it contains none of the above - mention'd *Animalcula*, which appear in the seed ; but, when the testicles and seminal bladders are wanting, it still remains, but is not prolific ; whence it seems to be a vehicle, design'd to dilute the grosser seed, and perhaps, upon the first act of copulation, to nourish the *Animalcula* contained therein.

The *Urethra* consists of two membranes, and an intermediate cavernous body ; this cavernous body is thickest betwixt the end of the *Prostata* and the union of the cavernous bodies ; and thence grows thinner in its progress, but is thickest towards the inside of the penis ; being outwardly bent, it leaves in the middle the mouth of the urethra open in the glans, and then forms  
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the outward spongy superficies of the glans, ending in its protuberant edge, where the *Præputium* is joined: it receives into the cavity of its passage oblique emissary vessels, from glands first observed by *Cowper*, which discharge a soft humor for the use of the internal passage of the *Urethra*: in the external superficies of the glans, it is covered with a very subtle membrane, under which lie very sensible nervous *Papillæ*, the chief cause of pleasure or pain; and under this thin membrane lies that which is wondrously full of cells.

The cavernous bodies, rising from the lower part of the *Os Pubis*, separately, and, being cloathed with their membrane, are joined together by a middle partition, called *Septum medium*, which gradually vanishes towards the fore parts: these make up the chief substance of the penis, which before, under the *Corona Glandis*, gradually grow less, and, forming the internal substance of the glans, end therein; this whole body thus formed is encompassed with a cellulous membrane of a wonderful texture, which also encloses the *Septum medium*; and then it is covered with a firm nervous coat, without the cellulous membrane, which limits its extension; and upon this lies the skin and cuticle.

Arteries from the internal iliacs, commonly convey blood into the cavernous bodies of the *Urethra* and *Penis*, where, being divided into innumerable branches, they are continued into veins, in which there are a vast number of hollow cells, that communicate with one another, and all discharge themselves into a great vein, running through the back of the *Penis*, under the ligament that joins the *Os Pubis*; dividing into two branches about the *Prostata*, and discharging themselves into the two external iliac branches on both



both sides; the veins of the cavernous body of the *Urethra* are also distributed to the muscles, called *Acceleratores*, for necessary uses.

If, therefore, by any cause, the animal spirits from the brain flow more than ordinarily, into the nerves tending to the muscles, called ereectors, (since these muscles, rising from the external protuberance of the *Ischium*, below the origin of the cavernous bodies, are inserted into the firm nervous coat of these bodies, and there terminate tendinous,) when the origins of the spongy bodies are more pressed by the swelling of these vessels, against the protuberances of the *Os Ischium*, and their veins are streighten'd, then the body of the penis will be pressed more to the *Os Pubis*, and to its middle ligament; the great veins of the *Penis* will be more compressed, and those of the preputium less; therefore both the veins and arteries will be filled, which will still more compress the vein, and then the cellulous sinus's will be distended with blood; and thus the turgid *Penis* is on both sides forced full of blood, as also the cavernous body of the *Urethra*, and that of the *Glans*; especially the moment before the ejaculation of the seed, and a good while after the erection of the penis; and the nervous *Papillæ* in the *Corona Glandis*, being much stretched and rubbed, presently occasion that ejaculatory contraction; and even at this time the causes of tumor are increased, which produce a stiffness, redness and strong erection: in the mean time, the muscular membrane of the *Prostata* and *Urethra* do and ought to swell, and all the nerves are extended; by which means the seed is pressed out of the seminal bladders, with the humor out of the *Prostata*, and gathered into that part of the *Urethra*, which is free from the erecting muscles; until the transverse muscles, which,  
from



from the external protuberance of the *Ischium*, are fixed to the upper end of the bulbous part of the *Urethra*; and, at the same time, the muscle, called *Dilatator posticus*, rising from the fore and upper part of the *Intestinum rectum*, and fixed to the lower and back part of the *Urethra*, at the same juncture dilate the *Urethra*: lastly, the accelerator muscles being violently contracted, (which rise fleshy from the upper part of the *Urethra*, under the *Os Pubis*, and encompassing the bulbous part of the *Urethra*; being joined together, descend, and, again parting, are inserted on both sides into the strong membrane of the cavernous bodies of the *Penis*) and the muscles of the *Prostatæ* and seminal bladders being at the same time contracted, the blood is chiefly drove into the penis; the *Glans* tumifies, and the spongy body of the *Urethra*, being very much swelled, at the last grows stiff, and the nervous fibres of the glans being highly excited, a convulsion follows, and the seed is thrown out with force: the urethra is then relaxed, and the spirits cease to flow; the vein is free, and the blood out of the sinus's flows into them; the extended parts again contract, and the *Penis* subsides.

From hence it appears, how far a man is concerned in generation, which indeed is surprizing; why the growth of the beard, *Pubes*, and perhaps their continuation, as also the voice, temper, a stated age, and passions of the mind are concomitants with, or soon follow the generation-feed.

But here we are to take notice, that the seed is very different from the nature of the spirits, a volatile oily salt; a hot, fermentative humor, being, according to our author, soft, viscous, and sluggish; yet if we consult the smell, and proper experiments, and observe that it is volatile, sulphureous, and soon grows rancid and fetid, it will, perhaps, appear of a like nature to, but  
higher



higher digested than them. Farther, it is plain, that the transverse muscles of the *Penis*, along with the back dilator of the *Urethra*, are of extraordinary use in dilating the lower part of the *Urethra*, which hath not hitherto been much observed.

Before we leave this subject, it may not be amiss to observe, that though *Animalcula* be found in the *Semen*, yet it does not follow, that they are of so extraordinary an use in generation, as our author supposes; since the like, though not exactly of the same form, are observed in vinegar, pepper-water, &c. factitious liquors, that are no ways concerned in any such action; nor is it so very likely, that they contain the rudiments of a future body, since their large numbers would produce too plentiful an off-spring; and the *Ova* in the ovaries become useless, and want no impregnation: but, of the effects of the *Semen*, more when we come to speak of conception.

All that we shall here further observe, is, that the liquor from the *Prostata*, though it seem, indeed, design'd to lubricate the *Urethra*, and dilute the semen, that it may pass easily through it; yet the chief and more especial use hereof appears to be this, that, upon a titillation of the glans, the muscular fibres of the *Prostata*, having a very near situation thereto, and the muscular coats of them are thereby contracted, and the liquor there contained, violently affecting the sensible membrane of the *Urethra*, it draws the seminal bladders more exquisitely into a consent, being nearer to them, and thus encourages the expulsion of the seed; whilst the membrane of the testicles, being also contracted, drives on a successive supply.





## C H A P. XXIX.

## Of the Menstrua, or Monthly Discharges.

**I**N a woman, the *Os Sacrum* is broader, and juts out more, than in a man; the *Os Coccygis* also recedes more backward; the bones, called *Innominata*, are broader and further asunder, and turn'd much more outwards below; likewise the lower eminencies of the *Os Pubis* lie more forwards, so that there is a greater space about these bones, and the capacity of the *Pelvis* greater than in men; yet, in women that are not with child, there is little to fill it; the fore part of the thorax is also much plainer in women, than in men.

But the blood-vessels, lymphatics, fat-vessels, nerves, membranes, and fibres are much looser in women; so that all the cavities, cells, and vessels are more easily filled, and the humors heaped up together; therefore the cellulous and fat membranes are thicker in women.

But, again, it is well known, that they perspire much less, and sooner recover a plenitude of vessels and strength, than men.

In the *Pelvis* is placed the womb, which is soft and pulpous, wholly consisting of vessels, easily extended, and very elastic; not fixed, but almost loose, and scarce pressed upon, being defended  
with



with the expanded membranes of the *Peritonæum*.

It is of the figure of a top, consisting of membranes and fibres; it receives arteries from the spermatics and hypogastrics, or internal iliacs, wonderfully united, by anastomosis amongst themselves, into the reticular plexus's, which encompass the whole womb every way, which at last vanish, and seem to form the greatest part of the substance or bulk of the womb: to these are added arteries from the external iliacs, bending upwards in an arch, and rising through the groin, from the upper part of the thighs, into the *Pelvis*, and there join the sides of the womb; the veins have the like rise and progress, and communicate with one another, so that the humor may pass and return out of one into all of them; in its inward cavity it is penetrated, not only by *Fallopian's* tubes, but a great many small openings, which sweat out a soft, watry, slimy humor, to soften and make the inside slippery, and preserve it from drying.

As soon as a virgin, in health, hath attained to her full growth, she begins to make more good juices, than are required to nourish the body, which, not being thus consumed, will fill the vessels, especially those in the womb and breasts, which are least pressed, so that these will be dilated more than the rest; and the lateral vessels, which discharge a humor into the cavity of the womb, being very much filled, will distend, and occasion pain, heat, and weight in the loins, *Pudendum* and groin, with a small fever; and the vessels of the womb, being dilated, will distil blood into the cavity of the womb; the mouth of it being then relaxed and moisten'd, the blood falls out; when the quantity of the blood in the vessels, being then diminished, they  
are



are less pressed, and so contract themselves again, and the blood is restrained from flowing, only the thicker part of the serum is discharged, and at last only the thinner lymph; but a superfluous quantity of blood being again made, it is more easily admitted into the vessels once stretched, than before; and thus the menses come and return, at different times in different persons.

There may also be a discharge made by vessels, like those already described, below the mouth of the womb in the *Vagina*; since many persons with child have it so at certain periods, without any danger of miscarriage.

But since the mammary and epigastric arteries, which go to the breasts, wonderfully communicate with one another by anastomosis, and the veins also do the same, it is plain, that when the uterine vessels are emptied, the mammary ones must be less distended; and therefore, when the *Menstrua* are near at hand, the breasts swell, and on the contrary.

From whence we may understand, why women, that are endowed with fibres of a harder texture than ordinary, those who are more dry or very muscular, and also, why those who use hard labor, have the *Menstrua* in less quantity, more seldom, and sometimes scarce at all; whilst the more lax bodies, that abound in juices, are fatter, less muscular, and live at ease, have them in a greater quantity, at shorter intervals: hence we may likewise understand, why this humor being restrained, it dilates other vessels, discharges it self by other ways, and passes off periodically at different out-lets; as also, in what persons they begin early, why they cease at a certain age, and sometimes too soon.





## C H A P. XXX.

## Of Conception.

**I**T appears, that two membranous canals pass out of the two uppermost perforations of the womb, being gradually dilated from a small beginning near the matrix, bent into cellulous hemicycles, and at last, in a large orifice, adorn'd with fleshy edges; they consist of an internal glandulous membrane, with fleshy cells: these tubes, in all sorts of creatures, at the time they desire copulation, swell, grow stiff, and are full of caruncles, or fleshy protuberances; and, in dead bodies dissected, have been found often with their borders embracing the ovaries; for various fetus's have been observed, of different sizes, in their cellulous recesses, in several places, according to the distance of time from conception.

There are fixed to the womb, at about two inches distance, two ovaries, by strong ligaments, and are encompassed and kept firm by other membranes, rising from the *Peritonæum*; they have a rough unequal superficies, and are large, of a spheroidical figure, enclosed in a firm membrane, and furnished by the spermatic and hypogastric arteries, which, before they enter them, are so united, that they seem to form one vessel interwoven into net-like plexus's, of which, in respect of their bigness, there is an incredible number; and the same may be observed among

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the veins and lymphatics, which are very numerous: all these vessels, with the nerves, as they compose the structure of the ovaries, are intricately mixed together, so that their fabric cannot be described; but in their superficies, under the membrane that covers them, may be found small round substances, which grow below to the substance of the ovary, in thickish calices, being full of a clear lymphatic humor, that becomes thick by the heat of the fire; and consist of two concentrical small membranes, fastened closely to one another: these ovaries may be found in all found women, though they are very small before they arrive at years of maturity; but gradually grow bigger in the time of child-bearing, and less in old age: these small round bodies stick fast in their calices, at the ends of the vessels before-mentioned, and after the venereal act scarce appear; but gradually swell, by degrees become clearer, and afterwards grow thick in the ovary, lift up and extend the membrane thereof, and dilate in the form of a nipple, so that they bulge out, and hang by their stalk, from which they are separated, and leave their hollow nest in the substance of the ovary; the membrane thereof being broke; which gradually grows together again: and lastly, in these bubbles, yet sticking to the ovaries, a fetus hath been found.

From all which it certainly appears, that these bubbles are eggs formed in the ovaries, and are supplied by a liquor wonderfully prepared out of the humors there; and that, therefore, so wonderful a contrivance was designed by nature for this use.

From whence, also, we may understand, that these tubes, growing stiff in the venereal act, embrace the ovaries with their strong musculous edges,



edges, like fingers, and compress them; and that, their mouths being dilated and expanded by this embrace, they force the egg thus ripened into their cavities, and gradually drive it forwards, by their vermicular motion, and, at last, protrude it into the cavity of the womb; and there cherish it, if the male-feed be present, or expel it, if that be wanting!

For if we observe what is common to all oviparous creatures, as well as what appears to the eye in viviparous ones, at different times from copulation; and also, what happens to females of our own species, both in a natural and preternatural state, when with child, ready to bring forth, and after birth, it will appear, that this method is neither impossible, nor contrary to nature, but universally true; it is also confirmed by false conceptions, miscarriages, and fetus's that have been found in the cavity of the abdomen.

And thus the male-feed, that abounds with living *Animalcula*, being stirred up by a great force, and heat, and perhaps with a great quantity of animal spirits, and drove with great force through the mouth of the womb, at that time open, and the valves of the neck of the womb then relaxed, into the uterus, that is then likewise turgid, moved, heated and render'd strong by a gentle inflammation, and moisten'd with its liquor and spirits; and the nervous *Papillæ*, in the wrinkled furrows in the neck of the womb, being tickled by attrition; the seed, I say, being then retained by the convulsive constriction of the womb, heated, agitated, and, meeting with the *Ovum*, the living part, which is incredibly small, enters through the then dilated pores of the glandulous membrane of the egg; and is there retained, nourished, grows to its navel, and suffocates



the rest of the less lively *Animalcula*; and thus conception is performed.

It may, therefore, happen in all that space, where the seed nourishes the *Ovum*; for 'tis performable by the seed being poured upon the *Ovum*, and thro' the *Fallopian* tube, applied to the ovaries; or by meeting with it in any recess of that tube, or in the cavity of the womb it self: but 'tis probable, that conception is most complete, when both these meet in the *Uterus*, and are mix'd at the same time together.

The egg impregnated is now contained in the womb, shut up by the contraction of its muscles, the membranous wreaths in the neck of the womb helping to close up its orifice, and hinder any thing else from entering; besides, the thick and tenacious juice, prepared in the glands placed there, and which is dried almost as hard as paste, concurs to the same purpose; and thus the egg swims in the abundance of humors, that flow to the womb at that time, by which it is distended and increased; and those humors, being there subtilized, nourish the embryo, and also, by enclosing it, defend it from unequal pressure; render the membranes of the *Ovum* thicker, and enlarge it, especially at that place where it is stuck to the ovary; so that there they form the rudiments of the *Placenta*, or after-birth, which seems to be the very calix of the *Ovum*; its substance increasing in dimensions every moment.

But whilst these causes concur, every day, to increase the bulk of the *Ovum* and embryo, and also, to enlarge the passage of the *Placenta* and its membranes; the *Ovum* now begins to take up the whole space of the womb, to be contiguous to the inward superficies thereof, and unite to it by vessels reciprocally received and inserted,



inserted, especially in the place of the *Placenta*; by which means, both the womb is every way extended, and, in the same proportion, all its vessels being enlarged, receive a greater quantity of humors, and consume the superfluous *Menstrua*; and then, by the same proportion that the passages of the ovum increase in the placenta, the emissaries of the *Uterus* are enlarged; so that the capacities of these being united, the vessels of the womb and ovum are joined together, and thereby hinder the flux of the blood or lymphæ out of the womb; the vessels of that part discharging themselves into the *Placenta*, and those of the *Ovum* into the womb.

And because the fetus is now joined to the *Placenta*, by the navel-string, which consists of two vessels that carry a humor from the fetus to the *Placenta*, and out of the placenta to the fetus; it is evident, that by these vessels the humors collected are continually renewed and supplied, which keeps them from stagnation and putrefaction.

And when this mutual communication of the vessels is enlarged so much, that the internal emissaries of the womb can discharge blood it self, and others receive it, then the abounding blood contained in the large arteries of the womb, being drove to the placenta, seems to be forced into its dilated vessels, to be changed in its structure, and be sent to the fetus; which appears from hemorrhagies in miscarriages, births, &c. the woman with child, or in child-bed, being wounded by the separation of the after-birth; and also, by the loss of blood in the fetus, the mother only being wounded; though the vessels not appearing in a dead body, and the whole membrane of the *Placenta* covering the superficies next the womb, seem to shew the contrary.



For, the whole body of the *Placenta*, being furnished with innumerable arteries distributed every where therein, without apparent glands, as in the cortical part of the brain; and being supplied with veins equally distributed, and lymphatics, chiefly consists of these: besides, it is enclosed with a thin membrane, which may easily be torn, rising from the *Chorion*, and extended over the convex or external superficies of the *Placenta*, by which it is joined to the womb; so that the *Placenta*, being placed betwixt the expanded membranes of the *Chorion*, is covered on both sides thereby. It receives two arteries from the end of the descending *Aorta*, proceeding backwards to the navel of the fetus, where they are sent out, sustained and defended, in the almost cartilaginous substance of the navel-string; carrying back from the fetus the blood which is less apt to circulate in it. The origin of the veins is so subtle, that it does not appear; yet they are all collected into one branch, which is also communicated to the umbilical vessels, or navel-string. This vein entering the navel, and tending upwards, passes through a fissure, in the middle of the lower and fore part of the liver, into the great sinus of the *Vena Portæ*, and there discharges the blood into it; but so, that opposite to the entrance of this umbilical vein, in that sinus, another vein is placed, which discharges it self right into the *Cava*, where it is fixed to the diaphragm; so that it may send blood either into the liver or *Cava*, and thence to the heart, to be distributed through the whole body.

But the blood from the whole body of the fetus, and the umbilical vein, poured into the venous sinus, proceeding almost to the auricle, partly descends into the heart, as in grown persons; but the rest goes into a middle cavity, placed



placed here betwixt the two auricles; in which vessel there is an open perforation, covered with a membranous valve, so that the moveable part of it respects the inside of the left auricle; from whence it appears, that this blood is drove out of the right auricle into the left, whilst the lungs do not act; or at least, in the part joining to the auricles, out of the venous sinus of the *Cava*, into the venous sinus of the pulmonary vein.

That part, which enters the right ventricle, is thereby forced into the trunk of the pulmonary artery, which, in the lungs that are then collapsed and heavy, meets with a great deal of resistance; so that it dilates that part of the trunk which is free from the lungs, and thus often causes it to appear bigger than the aorta: then it only passes sparingly through the lungs, and, proceeding gently, hinders the arterial vessels from growing together, and increases and extends them according to the increase of the fetus; from the lungs it returns into the pulmonary vein, and is mixed with the blood admitted by the *Foramen ovale*, as appears from the situation and progress; and the valve, fixed to the perforation, admits a passage out of the *Cava* into the pulmonary vein, but not the contrary; nor does the weak and slender motion of the blood hinder its entrance; from whence both pass into the left auricle, and thence into the left ventricle: but the greatest part of the blood, from the right ventricle, finds an open passage in the side of the pulmonary artery, every where of an equal breadth, entering, a little obliquely from the pulmonary artery, into the *Aorta*, through which it passes, from the former to the latter. All that blood, drove out of the right ventricle, easily overcomes the resistance of the blood in the *Aorta*, made by the contracted lungs; but the left ventricle,



driving out its blood, it mixes it self with that just described; therefore, the blood of the fetus has not the effect of the lungs upon it, though it greatly wants it: consequently, the most subtle part of the mother's arterial blood, separated in the vessels of the womb, and elaborated in the *Placenta*, is continually mixed with the blood of the fetus, which must presently flow through the minutest vessels in the body; but the thicker part is soon returned, by an opposite course, and mechanical necessity, in the umbilical arteries, to be alter'd and refin'd again by the breathing mother; the resistance, in its passage through the *Placenta*, preserving the fetus in safety.

Yet, in the other vessels of the womb, a nutritious lymphatic liquor is prepared, and made subtle enough to pass, out of the vessels of the womb, into the pores of the *Chorion*, and is more thoroughly altered in its vessels; then, passing into the vessels of the *Amnios*, is further perfected there, and discharged into the cavity of the *Amnios*, out of which the fetus takes it in at its mouth, and swallows it; where it stays till further digested, and is altered by the bile, pancreatic juice, and intestinal humor; and, being turned into chyle, is received by the lacteal vessels; the feces being driven towards the sphincter of the *Rectum*, and collected in the *Rectum*, *Colon* and *Cecum*; where it continues, being unable to over-power the contraction of the sphincter, till the action of respiration assists it; and so remaining till the birth, when this whole cavity is usually found to be full: and since it receives the saliva and mucus in swallowing, and other humors which flow to it in the stomach and intestines, these concur to the temper and disposition, as well as quantity, of the feces.



The kidneys at this time are large and greater in proportion, than in grown persons; and, being compounded of less, continually separate a humor into the bladder, and fill it, but in a small quantity, which urine is of a soft nature, and not sharp; but the sphincter hinders its discharge through the *Urethra*, that is not to be overcome without the help of inspiration; but, when it abounds, it passes into a membranous canal, that goes out of the bottom of the bladder, and, rising upwards, enters out of the navel, with the umbilical vessels, even to the root of the *Placenta*; where it ends in a particular bladder, consisting of a proper membrane, distinct from the *Chorion* and *Amnios*, being more subtle than either of those, of an oval figure, placed betwixt the *Placenta*, and covered with the *Amnios* and *Chorion*, turning back upon it, within the *Chorion*, and growing to it; this is the repository for urine, which becomes more plentiful, higher colour'd, and more like urine, the older the fetus, and the nearer it is to its birth.

And when the intestinal feces and urine are increased, and cannot be expelled, becoming uneasy to the fetus, by their bulk and acrimony; the top of its head being placed to the inward mouth of the womb, and its face backwards towards the *Os Coccygis*, the intestines and urinary bladder being also full, stimulate and twing the fibres, excite a troublesome sensation, motion and struggle in the muscles of the abdomen, and the whole body of the fetus, which increases the former uneasiness: and then, using its utmost endeavours to press downwards, occasions in the mother frequent motions to go to stool; so that, by the utmost struggles of the mother and child, the mouth of the womb is dilated and made more open, moisten'd and render'd slippery, with a  
very



very slimy liquor, which loosens the parts; the membranes, containing the water, called *Alantois* and *Amnios*, are broke, the water they contained flows out, and the head of the *Fetus* is forced into the dilated mouth of the womb; and then, the endeavours of the mother being increased, the fetus passes out through the neck of the womb, made slippery by a liquor, separated in the mucilaginous and oily repositories and glands; the umbilical vessels, or navel-string, the membranes and *Placenta*, or after-birth, following, and some blood also commonly along with them.

When this is over, the fibres of the womb and *Peritoneum*, the muscles of the abdomen and vessels, which at the last were so much distended, begin to contract themselves, especially the womb, gradually; whereby, they drive out, by degrees, the blood collected in the extended vessels, which is first clear, large in quantity, but presently, more diluted, and less, and at last thick, pale, and very little, which is called *Lochia*; and differs both in quantity, continuance, color, smell and thickness, as the mother suckles the child or not, or otherwise, differs in function and temper.

When the parts are contracted, the vessels resist the deposition of more blood; about the third day after the birth, the hypogastric, communicating with the mammary arteries, begin to pour into them more blood, which used to go to the womb; and also, a watry chyle, which fills them fuller, and distends them: upon this change of the motion of the humors, there happens a small fever, a tumor, hardness and pain of the breasts, and also milk.

For, the breasts, being placed free, only in fat, and a skin that is easily distended, and receiving  
external



external arteries from the axillaries, and inward ones from the subclavians, tending downwards into the *Thorax*, and passing out through the intercostals and the *Sternum*, they come to the breasts, communicating with the epigastrics; and, being strangely twisted and wound up in knots, they disappear, and at last send out small milky tubes; which, being united into larger, at length become great broad milky vessels; these grow narrower at the ends, and terminate, with a small pipe, in the middle of the nipples; from whence, by milky ducts, this liquor may return to the blood, and so back to the nipples again: these nipples, being nervous and spongy, have a great many emissaries, varying in number, that communicate by anastomosis, before they terminate; they have a small cavity, full of oily or fat repositories, and sometimes milky ones, and a great many nervous *Papillæ*; so that, by suction, they yield continual nourishment, by a supply of milk; and the greater in proportion, the more they are sucked.

This milk is easily turned into whey, cheese, cream and butter; the cheesy part growing very hard; it does not thicken at the fire, like serum, but presently grows sour when left to it self: it is sweet, white, and without smell; composed of chyle, and the soft oily humors of the mother's blood.

From whence it appears, why pain, hardness, distension of the breasts, elevation of the nipples, or droppings of serum towards evening, happen to women with child; and why these are increased during the three first days after birth; why, by repelling the milk, the loches are increased, and the contrary; why the color, taste, smell and strength of what is eaten, greatly alters the milk; why milk will scarce flow out of its own accord, but when



when first sucked, often flies out freely; why fetus's, of both sexes, have always milk in their breasts; why milk, of all other animal humors, chiefly turns acid; and why it easily turns to cream or cheese; also, why, at several distances of time, from eating or drinking, it is different; why, presently after eating, having fasted before, it communicates the retained good or bad quality of what was eaten; and is best four or five hours after meals; why, after fasting for twenty four hours, it is salt and ungrateful, yellowish, and soon grows fetid and loathsome to the infant; and lastly, what rule ought to be observed, in prescribing a good diet to infants.

To proceed, a fetus, in the time of birth, striving with its utmost strength, as soon as it is exposed to the air, dilates the *Thorax*, takes in air, and enlarges the lungs to their utmost extent, dilates their vessels, and lessens their resistance against the blood in the pulmonary artery; so that it rushes into the open vessels with force, passes by the arterial tube, and, flowing quick and plentifully into the pulmonary vein, presses upon the valve of the *Foramen ovale*, and shuts it; and, entering wholly into the left ventricle of the heart, it is again expelled, presses more upon the *Aorta*, and shuts up the arterial canal; then the blood, in the right auricle and the venous sinus, is wholly forced into the right ventricle, and so into the lungs, and respiration is performed, as in grown persons; the membrane of the *Foramen ovale* grows together at its edges, and the arterial canal is turned into a ligament.

The navel-string being tied near the skin, nothing flows thro' its vein into the liver, but the vein also is turned into a ligament; then the blood in the *Vena cava*, being moved brisker, presses together the oblique venous canal, which also becomes



comes a tendon; when the umbilical arteries, being shut, they presently grow together.

And respiration being now begun, the black, tough, shining excrements, like opium, are thrust out; and, by the same means, the urine is pressed through the *Urethra*, as in grown persons. By all which we may know, how far the father and mother are concerned in generation; what is the cause of barrenness in both sexes; whether a child can be produced, without the assistance of the male seed, by any other cause or art; whether the menstruous blood be venemous and malignant, or excrementitious and impure; whether a woman emits true seed; whether there is a mixture, ebullition and fermentation, or any other unusual action of both, to produce a human body; whether any certain place of conception can be assigned; whether a woman, besides cherishing and nourishing, contributes to the form of the fetus; or whether the effects of imagination, in a pregnant woman, will shew it; and also, what impregnation is.

Hence also appears the origin of the three membranes, both in respect of their matter and cause; likewise, of the *Placenta* and navel-string; and how the embryo and fetus is fasten'd to them; whether the fetus is nourished by the mouth, or navel, or both; and how differently, at different times from conception; whether a fetus hath all its viscera, vessels and limbs at once; or whether it changes its form, being first in that of a fish, then amphibious, and lastly breathes; or whether it breathes in the womb, or makes use of air; whether the meconium, found in the *Vagina Uteri*, or cast out thereat, shews the fetus to be dead; or any thing else; whether it voids excrements, and why not; why a superfetation seldom, if ever, happens; why many twins may ad-  
here



here to one *Placenta*, and yet have proper umbilical vessels and membranes; perhaps, because so many eggs grew in one calix; or whether this always proves true; lastly, why women with child are affected with loathing, heaving and vomiting, fainting horror, sickness at the stomach, hardness of the breasts, pain, tumor, leanness, stoppage of the *Menstrua*, shortness of breath, a cough, swellings in the veins of the feet, legs, thighs and belly, and are very apt to fall.

Thus far we have trod in the steps of the accurate *Boerhaave*, in his judicious collection of the sentiments of the most eminent authors, relating to this matter; from which we can see no reason to vary, except in respect of the cause of conception, and the place. I shall not spend time in controversy, but briefly propose what I think upon that head; and leave the reader to accept which opinion he pleases, as I have upon all other occasions.

'Twas observed, in the chapter of the nature of the male-seed, that not only snake-like *Animalcula* are observed therein, but also in vinegar, &c. which have no relation at all to the cause of impregnation; and therefore, it will not follow, that the appearance of such demonstrates any prolific quality: besides, that opinion does not shew, how these should move the *Ovum* out of the *Ovarium*.

I suppose then, the seed containing volatile, oily, saline parts, as appears by its fetid smell, oleaginous substance, and the proper experiments, that this being in the testicles digested to a higher degree of perfection, than the nervous fluid, which gives no sign of so heighten'd a digestion; when it is deposited in the bottom of the womb, and there retained, it is still farther digested, and grows more volatile, fetid, pungent, and stimulating; which volatile parts, adding



ding to the heat occasioned by the act of copulation, twinge and stimulate the nervous fibres of that part, and thus cause a more than natural heat; this heat bringing on a fermentation, and a moderate degree of inflammation, occasions a greater flux of humors to the part, and parts adjacent; which render the *Tubæ* rigid, and fit to grasp the ovaries, that are also heated by the *Effluvia* of the *Semen*, and the warmth of the parts surrounding; this brings on a greater flux into the *Ovaries*, and consequently the *Ova*, or some of them at least, must, by a greater supply of nourishment, increase in bulk; and since those that are grasped by the edges of the *Tubæ* will be kept warmest, and the greatest flux will be made to them, they will soonest be ripen'd, fall off and be received by the *Tubæ Fallopii*, and conveyed to the womb; where at first, and all the while, they grow like the seeds of plants, till the *Placenta* takes hold of, and adheres to the *Uterus*; and then the embryo is nourished after a different manner, as we have already shewn: so that, I suppose, the rudiments of the body are laid in the *Ovum*, in the *Ovary*, upon the *Colliquamentum*, occasioned by the male-seed, and directed into form by the primary grand cause of our being. And I suppose, that to be the proper place of conception, where the *Colliquamentum* in the ovaries is made; which very likely, may be upon its first growth; since the primary humor was sufficient to lay a foundation for the rudiments of the body; and this seems more likely, than that an additional quantity of matter should dilute the rudiments of the solid organical parts to be formed. And it is much more probable, that the *Ovum* should contain the ground-work of a body, since it is prepared with great industry and  
con-



contrivance; than that those *Animalcula* should lay it, which are immensely minute, and so little evident to sense, that we are not sure, though they have motion, that they have life: for we are well assured, that fluids, containing parts of a different nature, as the *Semen* does, are always in motion; and that some move differently from the rest, which may be what we call *Animalcula*. Many other arguments, might be used, consistent with reason and experimental philosophy, to prove what is here offer'd; but this place will not admit thereof.



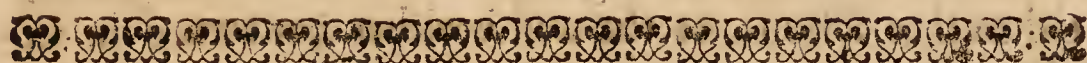
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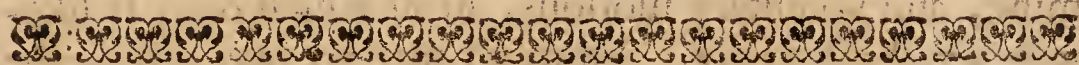


O F

# P A T H O L O G Y.



## P A R T. II.



### CHAP. I.

#### Of the *Nature of Diseases*, and their *Differences*.



Hitherto we have explained the principal actions, with their causes, which happen in the parts of human bodies, by the motion of the humors in their distinct vessels, and the effects they have upon one another. These actions, commonly called functions, are distinguished into vital, natural and animal, in respect of both sexes; and they are either particular or common. Those, called vital, so much conduce to preserve life, that they are of absolute



lute necessity; as, the muscular action of the heart, the secretory action of the brain, that of the lungs, and of the blood and spirits, with their motions through their proper organs; and also, the veins, arteries and nerves, which, as to their perfection, may be greater or less, increased or diminished, and yet life not be destroyed, but continue. The natural actions are such as so alter our aliment, that they may become part of our substance, and such are the actions of the viscera, vessels and humors, that receive, retain, move, change, mix, separate, apply, discharge, and consume; and these, also, differ very much amongst themselves. The animal functions are such as when perform'd, the understanding conceives ideas of things, united to that action; or the will is either concerned in exciting such actions, or moved by them when excited; such are the touch, taste, smell, sight, hearing, perception, imagination, memory, judgment, reason, passions of the mind, and voluntary motions; in all which there is likewise a vast difference. From whence we may physically understand, what life properly is; how long it continues; wherein it chiefly consists; and what it may want, and yet, continue in a good state of health. From hence, also, we know, that health is such an apt disposition of the body, as fits it to exercise all its actions. Lastly, it is plain, that all the effects of those actions respect determinate motions, and the change and alteration made in our aliment.

Such a state of a living body, as prevents the faculty of exercising any such action, is called, a disease. The idea of which is, the absence of what was required to render the exercise of an action possible, or the presence of what hinders the same. The mind is not taken notice of in this definition; because the same state of mind inseparably attends the determined state of the body. And because physic, only acting upon the body, restores the usual conditions of the mind; and because the altered state of the mind is unknown, and cannot be distinguished whether



ther good or bad, with regard to health, except by the corporeal effect, already manifest and known.

Therefore, the nature of all diseases whatsoever, is to be known and discovered in the different conditions, of a body variously affected, well observed, declared and explained. It is of no use, to talk of the first animating faculty, or power, as some famous men, in this art have done.

Whoever, therefore, would perfectly understand all the conditions requisite for action, must take a clear view of the defect of the condition, from the known distemper; and again, from the known defect, find the nature of the disease, which must necessarily follow; which part of physic, is called pathology, as it treats only of passions or diseases, and is divided into three branches; *first*, that which treats of these causes of distempers; *secondly*, that which treats of their differences; and *thirdly*, that which treats of the effects or symptoms thereof.

Therefore, as the actions may be distinguish'd, so may diseases likewise; and, as the conditions of those actions are known, so are also their defects; hence proceed, *first*, diseases of a simple, solid, or organical part; *secondly*, diseases or humors, as to their nature, quantity and accidents; *thirdly*, diseases compounded of these two, and which belong to mankind, both males and females. To these classes all diseases may briefly be reduced.







## CHAP. II.

## Of Similar and Organical Diseases.

A disease of a most simple solid part, called similar, is chiefly seated in the minutest fibre, which, since it is a mere earthy, small, simple, nervous body, or a substance rising from the nerves, composed of the most simple terrestrial parts, joined together by a proper, determinate force, it is affected, more especially, with diseases which proceed from too great force, weakness, stiffness, relaxation, or solution of unity; the four first of which have always a respect to the symmetry, or regular disposition and conformation of the body they belong to; so that, what is healthful to one, is often the cause of a disease to another.

The same disease, with its differences, happens, *secondly*, in a membrane composed of the least of these fibres, joined together, and interwoven one with another: and, *thirdly*, in the small nervous canals, formed by a cylindrical concretion of such a membrane. *Fourthly*, in a membrane made up of such hollow canals, by the help of fibres, which form the whole. *Fifthly*, in canals, made of such a compounded membrane, as all the great vessels of the body are, which differ from one another in their various degrees of composition. *Sixthly*, in those solid parts, which consist of canals compressed and growing together, and void of humor to distend them; or of such as grow into one thicker part, the gross humor hardening together along with the proper vessel that contained it: for if we take notice of distempers incident to all these separately, they will appear to be such as we have just described.

But



But in these parts, that are once found, diseases may happen in respect of their structure, if the least solid nutritious parts are disordered, or ill applied; and the particles, which are to be applied, may prove bad, in respect of their bulk, figure, or solidity; and there may be as many diseases occasioned by their false appositions: and whoever shall enquire further, into the origin of these distempers, must treat of the depravation of the humors, or else of the subtilty of the parts that are not evident to sense, or useful to a physician; wherefore, similar distempers, of the temperament, elementary diseases, or of the whole substance, as they are termed in the schools, can neither here take place, nor be understood, but are to be reckoned organical.

When any compound part of the body, consisting of the parts just now mentioned, can perform its office, which is to be done by the motion of the humors, and help of the instrument; or can perform any other function, by vertue of its conformation or structure, it may be consider'd, in it self, as a solid part, or with respect to the humor it contains: if the first, then organical diseases in that respect may be reduced to these four classes.

*First*, diseases of the figure, hurt in the external or internal superficies, and also in the accidents attending both, as the roughness, smoothness, streightness or crookedness, laxity or firmness, hollowness or solidity, which are called diseases from a bad conformation. *Secondly*, diseases of excess or defect, in number. *Thirdly*, of magnitude, increased or diminished. *Fourthly*, in respect of situation or connection; and motion in excess or defect.

But the superficies, which was before found or natural, tho' afterwards hurt or damaged, consists either in the various union of the compound parts, or in the disorder of the humors which are contained therein. And as this superficies forms cavities, so as to make small passages, sinus's cavities, and receptacles, they also may be



erroneous in number; whence sometimes distempers happen, either in cavities that exceed the natural bigness, or are too little and deficient, in their capacity.

If the natural bigness of a cavity is increased too much, or a new one formed, a threefold disease ensues, which is called *ἀναστόμωσις*, when one vessel opens into another, *διαπύλνσις*, when a rupture is made; and *δαίρεσις* when a breach is occasioned by corrosion: in the first, the mouths of the dilated cavities let out what they should retain; in the second, the parts, which form the membranes, are so pulled in pieces, that their open interstices, or intervals, cannot contain what they ought, and in the third, the vessel grown too large by the force of the humors, in respect of its capacity, causes a disease consisting of the matter that was to flow through it, and be there separated or discharged.

Of the cavity diminished there are five species; as, first, *ἐμπερίαξις*, which is a total obstruction of the cavity, by a viscous, thick, grumous, inflammatory, stony, purulent or fattish substance, inwardly stopping the orifices of the vessels. *Secondly*, *στενοχωρία*, a narrowness of the passage, when a tumor is in the proper substance of a membrane, which forms the cavity, and making the canal narrower, hinders the passage of the humors. *Thirdly*, *ἀνίψις*, or a compression of the moveable sides, when an external cause presses the sides of the vessels together, gradually diminishes, and at last wholly blocks up the passage. *Fourthly*, *σύμφοσις*, when the sides of the vessel, either by matter within, or pressure without, are quite closed up, so that the whole cavity is lost. *Fifthly*, *συνίησις*, when a vessel is so emptied, that the sides fall together and the cavity is lost; which happens when the vessels are too much distended beyond their tone, and then too suddenly emptied; to which kind may be referred, the too great contraction of the vessels, by the force of the orbicular fibres.



An organical part seldom errs thro' excess in number, so as to cause a disease, except the action be hurt thereby; but by defect it often makes a disease. Magnitude in a part often produces a distemper, either in excess or defect; the first comprehends nodes, exostoses and exuberant callus's, which occasion contraction or streightness of passages, about the narrower ends, or a dilatation about the middle of a part: which may be occasioned by κακοχυμία, ill humors; ἐκχυσις, extravasation of humors; or, δαίρεσις, a loss of fluids; and the latter happens, when a part is not of the proper bigness, as in a consumption, and phthisis in too great contraction a weak temper, and when a part is lamed.

Lastly, an organical disease of the parts consists in an ill composition of them, in respect of situation and connection, wherein consists the mobility or immobility of a part; of which kind are those, where the parts joined are of a wrong figure, or the ligaments too short, too long, too slack or stiff; also when separated by rupture, or matter is wanting betwixt the parts that are to be joined together, or it be depraved of an ill temper; also when the parts are distorted, strained or out of their place, which last three diseases happening upwards, downwards, forwards or backwards, inward or outward, have different names to distinguish them to the intellect. Ruptures of the navel, in the groin, scrotum, and bladder in men, in the thighs in women, also of the caul, and intestins, by fat, air or water, entering into them; falling down of the womb or *Intestinum Rectum*, or the disorder of muscles and tendons, especially when springing out of their places, and the relaxation or rupture of membranous ligaments, are the primary distempers which relate to this class, and which are very necessary distinctions in physic.

But there is a distemper of the solids which is common both to simple and organic parts, and simply called a solution of continuity, if in a simple part, but in a compound organical part it is variously term'd according to the nature of the part, the difference of the causes, and application



application; of this kind are wounds, contusions, ulcers, corrosions, dilacerations, ruptures, fractures, fissures, caries, and a *Spina Ventosa*.



### CHAP. III.

#### Of the Distempers of the Humors.

**T**Hat the distempers of the humors may be rightly understood, and digested into good order, we ought to know that the qualities requisite in them, are, either universal and necessary to every liquor, or particular to such as belong to mankind; we are likewise to consider the disposition in the liquors which diversifies the temper of this or that person. The universal properties of fluids are to have their parts so very minute as not to be discovered by the senses, and their force upon mutual contact so small as to be exceeded by the least sensible force, and the smoothness of their superficies so great that they scarce make any impresson upon one another. But in respect of human nature there are a great many other qualifications whence very many distempers arise. All which distempers nevertheless may be referred to the quantity or quality hurt, if they be looked upon as consisting in the fluids.

But if they are considered as contained in solid vessels, then their errors will seem to depend upon their place and proportion. A good humor abounding too much, and which prejudices the functions is called *πληθώρα*, plenitude, which is caused by good chyle and plentiful sanguification, together with a small expence of the exhalable humors. And this is considered both in respect of the vessels and strength.

That



That want of good humors whereby the functions are depraved, seldom happens; except from some sudden external force, whence there arises an ill disposition of them. That quality of the fluids that obstructs the the functions is called *κακὴ χυμὴ* an ill habit or disposition of the humors; is either in the fluids, as they respect the separate parts which compose their mass, or the whole mass of them together, considered as a part concurring to form the body.

If the distemper'd disposition in every particular humor be considered, it will appear to consist either in its bulk increased or diminished, the too great or too little solidity of its particles, or in the figure; and also in the stiffness, flexibility, elasticity, various cohesion of parts, or their divisibility, or aptness to be divided.

The idea of the bulk increased in the parts of the humors, shews them impassable and concreted, and an emptiness and consumption in the lesser vessels. The idea of their bulk diminished, shews their perspiration and too great discharge. Too much solidity in the parts of the humors arises from too great a force altering both the solids and fluids; there being at the same time in the solid parts a dilatation, a rupture and corrosion of the vessels, with too much attenuation and attrition in the fluids. If we suppose solidity too much diminished, there is an inability and sluggishness both in the vessels and humors, and presently perfect rest and a cohesion of them succeed.

A particle of humor is offensive by its figure, especially when from spherical it becomes acuteangled, for then applying all its force of motion to a small part it becomes pungent; and these alterations are various but may most aptly be referred, first, to a sharp one, which is merely mechanical, for whilst all things else remain the same, the particle only acquires solid, acute angles. Secondly, to an acrimonious saline particle; which is here especially of the nature of sea salt, ammoniacal, acid, a little alkalious, fixed, volatile simple or compound. Thirdly to an oily one, which is of an unctuous nature, attenuated into spirit,



Spirit, an oyl almost burnt with too much attrition, a saline oyl, an earthy oyl, or a sharp one as if compounded of a saline and earthy part burnt together. Fourthly, to a soapy acrimony, such as is found in the poysons of animals and vegetables. Fifthly, to an acrimony compounded of the four former; and lastly, to that which is bred in the body by the use of sharp things, as from mineral vitriols.

There arises another cruel and scarce curable disease from a humor, when its particles are so inflexible, that they cannot be subdued, figured and divided by the force of a human body into convenient masses. Those parts are also distempered which are too changeable in their figures, whose superficies being plain, easily stick together, the places of contact being thereby increased.

And it is very remarkable where a disease proceeds from parts of too elastic a nature in the humors, these continually break and disorder the whole frame of the humors, and excite too much heat and motion.

Also too firm a cohesion of the parts and substance of the humors any where is bad, since it hinders the greater and grosser from being divided into less and smaller parts, which nevertheless is necessary for the preservation of life. On the contrary, too great a disposition to be easily divided is noxious, being repugnant to the continuance of health and life.

These distempers are of the greatest moment in physic, and the knowledge of their nature must be the best pathology: but they can scarce be understood, except by an accurate observation of the effects which they produce in disordered bodies; which seems to be the best way to understand the proper nature of diseased humors.

And if we consider the whole mass of humors together we shall find their distempers chiefly to be, either too great fluidity, tenacity and grossness, moving too quick through the vessels, or too slow, or lastly by a compound disorder of those faults of several ill disposed parts before mentioned.



Many considerable diseases happen also in humors that remain unaltered, being only distempered by the change of their place, of which there are two sorts. First, if the diameter of the vessel be too much altered and increased, the thicker humors will be received into the closer vessels, which thence gradually grow narrower. Secondly, if the humors flow out by a rupture of the vessels and are collected in the intervals made by that distension amongst the solid parts of the body, as it happens in inflammations, aneurisms, varices and *Ecchymoses*, the blood and humors being extravasated into the interstices of the extended parts; thus an *OEdema*, or phlegmatic tumor in the parts, a dropfy of the head, thorax, abdomen, the womb, ovaries, testicles, the *Scrotum*, *Peritoneum*, and a tumor of the whole habit of the body proceed from lymphæ, collected in cellulous membranes or otherwise out of place; and lastly, an *Emphysema* from air.

These humors, thus collected and stagnating, being out of motion are soon putrefied by heat, grow purulent, ichorous, corrosive and sharp; destroying the solid tender vessels, which produces sinus's, fistula's, ulcers, gangrenes, sphacelations, cancers &c.

And these are the primary differences of diseases, derived from the nature thereof, which are generally so fruitful in producing other distempers, that they may in a great measure be esteemed the causes of them. But physicians have made it customary to distinguish diseases from some external accidents, which are common to a great many very different ones. These distinctions have their use though multiplied with too many subtle subdivisions; the chief of them are the following.

In respect of the cause, they are idiopathic, sympathetic, protopathic, and deuteropathic, hereditary, connatural, or acquired. In respect of the subject, distempers according to age, belong to children, to grown persons and old ones. Distempers belong to either male or female, virgins, women with child, in child



child-bed, to nurses, and those either universal or particular. In respect of the time, they are either most acute which terminate in four days, very acute which end in seven, or acute that continue for twenty days; all the rest are chronic; again they are either, vernal or autumnal, continual, continent or intermitting. In respect of the effects, they are healthful, benign, malignant, curable or incurable, deadly or contagious. In respect of their time, they are either said to be in the beginning, increase, state, decrease, or end.



#### CHAP. IV.

### *Of the Aiteological part of Pathology, or the Causes of Diseases.*

**T**Hat is said to be the cause of a distemper which makes it present; it is almost always real, or really produces a new state in the solids and fluids, which is in a manner the distemper it self. Or, the cause of a disease takes away that which is requisite to the exercise of the functions.

If it remains some time in the body before the effect be produced it is called internal; but if it comes from without, and applied to the body produces a distemper, it is called external. Internal causes commonly affect the humors first, and then the solid parts; external causes chiefly work upon the solids and then the humors; except in a few venemous and contagious distempers.

The proximate, or most immediate cause, is all that which occasions the present illness; and this is always the intire, sufficient, and present cause of the whole distemper,



per, whether it be simple or compound. The presence hereof makes, and continues the disease, and the absence takes it away. It is almost the same individual with the whole distemper; and, therefore, it is very useful and necessary to be inquired into.

The remote cause of a distemper is, that which so changes the body, that it may be fitly prepared to receive the distemper, if another accessory cause shall be added. It is not, therefore, any cause alone, nor sufficient of itself to produce the distemper. Nor is it that other cause alone, that would produce it, but both together; and, therefore, we ought to extirpate them both together. The conjunction of both these causes make the proximate cause.

The remote cause, inherent in the body, is called the predisposing cause, and is either the temper, a *Plethora*, or *Cacochymia*.

The cause which is accessory to the remote cause, excites, and stirs it up, so, that joined together, they make the distemper; and this is called the procatactic cause, or the occasion. This puts the predisposed causes in action, so as to produce the distemper.

These latter may, very conveniently, and with great help to the memory, be reduced to four classes, which are exceeding proper for discovering and digesting them, and they are; First, Things that are taken into the body, as air, meat, drink, medicines, and poysons, which enter in through the pores of the skin, the mouth, the lungs, *Oesophagus*, stomach, intestins, and the *Pudenda* of women; whether in a visible or invisible manner, by smook, suction, swallowing, glyster, or infusion. Secondly, What we act or suffer, as the motion of the whole body, or any part thereof, and all passions of the mind, the rest of both; to which may be referred sleep and waking. Thirdly, Things retained, as excrements, whether wholesome, recrementitious, or distempered. Fourthly, Things externally applied to the body, as air, vapors, fomentations, baths, cloaths,



cloaths, liniments, unguents, plaisters ; or any thing that wounds, bruises, or corrodes.

These are divided, by others, into six classes, and are called the six non-naturals, as first, the air ; secondly, meat and drink ; thirdly, motion and rest ; fourthly, passions of the mind ; fifthly, things retained and discharged ; sixthly, sleep and watching. They are thus called, because, by their use or abuse, they may be good and natural, or bad and unnatural.

The air, when it is too hot, dries up the moisture of the eyes, mouth, nostrils and wind-pipe ; heats the blood too much in the lungs ; and is both ways prejudicial to them, from whence a great many distempers proceed. It consumes the thin humors, externally, and too much digests what remain within ; it dissipates and disperses the most volatile, thickens, dries, and agglutinates the grosser, and thus, continually, diminishes the watry, spirituous, and volatile saline parts ; but increases and heaps up the more fixed salts, and the thick and cloggy oyls ; as also the sharp salts, and what are contained in them, with the more fixed and earthy parts, which, it not only collects, but unites together, so that they are not easily separated again ; this makes the humors unfit to discharge, and debilitates and weakens the solid parts ; from whence proceed obstructions, dryness, and inflammation, want of concoction, putrefaction, costiveness, thirst, strangury, high coloured urine, cholic humors, acute and hot distempers ; and is very prejudicial to the nerves, lymphatics, and their actions. The air, when cold, shortens the solid fibres, thickens and strengthens them ; which increases their action upon the humors ; but when it grows warm it dissolves and destroys them ; the cold air also condenses the humors, dries up, and binds the lungs together, and coagulates the blood in the lungs, which occasions obstructions, inflammations, dryness, short breathing, coughs, and catarrhs, phlegm, matter, gangrenes, and sphacelations ; and if the body be much moved, then the actions of  
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the solids upon the fluids, and the fluids upon the solids, is so increased that it produces the greatest attenuation and perspiration, also hunger, weakness, faintness, and sudden death: if, on the contrary, the body be at rest, and extreme cold affects it, then numbness, pain in the limbs, and the scurvey, ensue.

If the air be too moist, it relaxes and weakens the fibres, especially in the lungs, it retains and encreases the serum in the lungs, and hinders perspiration; which occasions coughs, peripneumonias, diarrheas, numbness, and fevers. If much heat attends, it produces putrefaction; if much cold, a great deal of phlegmy serum. And when the air is too dry, it has much the same effects, as too much heat.

When the air is too heavy, it compresses all the vessels, and the humors, especially in the lungs, which resist the motion of the heart; and the motion of the humors is thereby suffocated and made dull.

So if it be too light, pressing less upon them, it dilates and rarifies the vessels and humors; which occasions tumors and eruptions of the fluids; they being pressed into smaller vessels, less fit for them; which produces distempers. Besides the contractive power is less forcible to over-balance the resisting power of dilatation in the vessels of the lungs, which hinders respiration, and the blood is heaped up, and stuffs the lungs; which occasions a *Peripneumonia*, and death.

The weather, the season of the year, the ground or soil, the sea, mountains, lakes, ponds, rivers, vapors, exhalations, and meteors, so much alter the air, that it occasions several distempers, not so much depending on the air, or its qualities, as the nature and effects of what is mixed with it; which ought to be considered, and enquired into.

The winds also act upon our bodies, either by their motion, or as they convey to us the qualities of the air, which also differs, according to the season, and the country; in which case the knowledge of the nature of  
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the soil, in neighbouring places, compared with the seasons of the year, will be of some use and information. They likewise produce considerable effects by following in a successive order; tho' they act primarily, as hot, dry, cold, or moist; and so change the solids or liquids, accordingly.

Meat and drink may produce distempers; by an error, in quantity or quality. In quantity they may err, either in excess or defect. If they be erroneous in quantity, the stomach is too much distended, and a convulsion being raised, by that means, contracts the mouths of the stomach, and its vessels are compressed; by which dilution, digestion, attrition, separation, and expulsion are hindered; and the quantity of liquors, assisting digestion, disproportioned to the quantity of the contents; which hinders also the action of the part. This extraordinary load upon the stomach obstructs respiration, and occasions a difficulty in that action, perverts the circulation of the humors, occasions crudities, belching, loathing, the heart-burn, vomiting, putrefaction, giddiness in the head, confusion, an ill habit of body; all which thus, at once, attending, the faults of this place are scarce corrected in the following actions of the body, and thus the blood is filled with crudities.

If the food be too little in quantity, and there is a real deficiency, this, of itself, can do no hurt; but then the actions of life continuing to wear away, and destroy the solid parts of the body, dissipate the most subtle humors, and thicken the rest, and by a continued attrition dissolve the oily and saline parts, and make them volatile, sharp, and corroding to the small and tender vessels, putrefy the humors, and make the breath smell strong; then a salt froth, sharp, choleric and putrid ensues, first in the stomach, and, afterwards, in the intestines; then comes on belching, loathing, fainting, a great and fierce appetite, and next a total loss thereof; afterwards a great thirst, dryness, weakness, and gripes, rumbling in the guts, an accumulation of choler and vomiting,  
leanness



leanness and want of sleep, epilepsies, distracted fever, and, at last, death. Whence it appears, that abstinence creates more distempers than too much eating and drinking, and that it is much more difficult to alter and cure those arising from the former than the latter cause.

But those faults which consist in the qualities of meat and drink, may be reduced to acrimony, visciditv, or oylinefs.

The acrimony of meat and drink proceeds from salt, which is either like sea-salt, of itself acid, and fermented. The first occasions thirst, hoarseness, roughness, dryness, stiffness, and acrimony in the most serous humors, a dissolution of them, and an unaptness in the serous lymph to afford nourishment; destroys the least solid parts, occasions pains, and the scurvy. The other which is a simple acid, or rather acrid or austere, binds together, thickens and coagulates, and thus the acid acrimony occasions tormenting pains, heart-burnings, paleness, and the itch; and these qualities reside in unripe fruit. The third, being contained in sharp wines and vinegars, hath much the same effect, but in a less degree. Too frequent use of these sharp or sower things produces rheumatic pains, and the gout.

Another sort of acrimony is produced in the blood by aromatics in meat and drink; such commonly consisting of an oyl and salt united together; these occasion thirst, heat and burning, stimulate the solids, quicken the motion of the humors, and dissipate the liquids; too great use of such things, occasions heart-burning, a burning heat of the stomach, loathing, belching, vomiting, fevers, leanness, contractions of the parts, and such diseases as depend thereon.

The third kind of acrimony is from spirituous, things prepared by fermentation, improved by a long continuance and distillation; this quality is most commonly found in wine, stale beer, and distilled spirits; it occasions thirst, trembling, a constriction of the fibres, a coagulation of the humors, scarce to be resolved again, a



short and brisk twinging of the solid parts, and a continual necessity of a supply of the same liquor; from whence proceed weakness, windy vapors, obstructions, tumors, dropfies, and the like.

*Fourthly*, There is a sort of penetrating, fermenting acrimony in wines made of fruit, or in wine or beer, bottled up in the time of fermentation; this causes wind and vapors, convulsions of the stomach and intestins, vomiting, surfeits, diarrheas, dysenteries, the *Iliac* passion, and the like.

Too much viscosity, or thickness of food in flower fermented, or gellies made from parts of animals, tough cheese, or curd, too much hardened, occasion a weight and clogging pain at the stomach, wind, belchings, acidity and crudities, obstructions of the small vessels in the intestins, which makes them feel heavy and sluggish, producing a tumor and hardness of the *Abdomen*; and, by degrees, occasions a viscosity in the blood; the viscid parts being again united together: this brings on obstructions of the glands, paleness, sluggishness, cold, and tumors, and things which are said to be cold, *in potentia* produce the same effects, and are, especially, hurtful to bodies that indulge ease, and avoid exercise.

Too much oyliness, softens, relaxes and weakens the solid parts, obstructs the mouths of the smallest vessels, and hinders the passage of the more fluid parts, prevents the due mixture of the humors, and occasions hot and sharp fulsome humors or vapors, belchings, loathing, oily, bitter vomitings, also obstructions, inflammations, and indigestion in the *Viscera*.

Too much motion of the muscles of the body, or any single part, increases the contractions and relaxations of the small muscular fibres, and promotes a free motion in the humors; hence the fluids and solids are dissolved by too great attrition, the watry, spirituous, and more volatile parts fly away, and are dissipated, and the rest become thicker and inflamed, whilst the oily and saline parts, being attenuated, rendered volatile and acrid are  
exalted



exalted almost to the degree of putrefaction, and the thick and viscid oily parts, collected together, the humors being, as it were, burnt and adust, especially the bile; the marrow is wholly consumed, and the cells filled up with an *Ichor*, and the body becomes lean; when the whole being tired and worn out, pain, inflammation, and a fever, suppuration, a gangrene, hemorrhage, and, at the last, death ensues; if this happens to be one of an ill habit, or any viscus is almost wasted, then comes sudden death in the height of inflammation.

Too much watching consumes the spirits; that can be repaired by no art, without sleep; it dries up all the parts, consumes the solids and liquids. especially of the brain; increases sharp humors, hinders concoction and nutrition, exasperates the bile, and occasions leanness, a fever, and *Delirium*, increases black cholera, occasions sadness, depraves the imagination, and brings on perpetual uneasiness.

Too much rest from motion, in the whole body, or any particular part, makes the fibres more unapt for motion, causes all the humors to move slower, which grow thick, and render the person slothful, and the fluids, as well as the parts that contain them, unapt for motion; the medullary cells, and those which contain fat, are then also filled up, and the person grows drowsy and sluggish.

Excessive sleep consumes the volatile parts of the fluids; and, by degrees, thickens the rest, and collects them together in the lateral vessels; hardens the excrements, and makes the brain heavy, and sense and motion dull, and is most hurtful to those that are most subject to it.

Violent passions of the mind, or the same continuing too long, dull, alter, and deprave the brain, nerves and spirits, as well as the musculous parts; which, as they are different and continue, may lay the foundation of a great many diseases.

If the saliva be discharged, or spit out in too great quantity, it prejudices concoction and digestion in the stomach, and, consequently, all those that come after, it



occasions thirst, dryness, and a consumption ; and if it be not discharged into the mouth, or less than usual, it is a hindrance to the chewing of the meat, tasting, swallowing, and digesting thereof; and also occasions thirst.

If choler be discharged too much upwards or downwards, it hinders chylicification in the first passages, and its separation, as well as the discharge of the excrements; makes the constitution acid, and the body cold, weak, and pale. And, if when it is made, it does not flow into the intestins, it occasions the jaundice, as well as the forementioned inconveniencies.

The lymph of the *Pancreas* and intestins, if laid down in too great quantities in the intestins, produces the same inconveniencies as the saliva, if alike in fault or error ; besides, it often occasions diarrheas, or serous fluxes, from whence proceed weakness, fainting, thirst, a hectic fever and weakness, or that sort of consumption called *Marasmus*, which is a universal decay of the whole body. If it does not flow into the intestins, or but sparingly, it causes thick humors in the guts, a weight, gripes, and the iliac passion, thirst, a fever, a hard and tumified belly, &c.

Voiding of too much blood, either by anastomosis in the liver, guts, kidneys, or womb, whether through vessels corroded or broken, or by wounds, sinks or diminishes the strength, wastes the spirits, destroys all the actions, occasions crudities, watry, pale, and cold humors, and a dropsy ; it empties, and causes a laxity in all the vessels, and even in the arteries. The usual periodical discharges of blood, made by the hemorrhoidal vessels, or the proper vessels in women, or other less usual ways being now stopped, occasion particular and large inflammations, obstruct circulation, and encourage fevers, and a great many other strange distempers, especially considerable hemorrhages other ways.

If the seed be discharged in too great quantities, it occasions an indisposition to motion, weakness, and convulsions,



vulsions, leanness, dryness, pain of the membranes of the brain, dullness of the senses and eyes, and the *Tabes dorsalis*, also foolishness, and such like diseases.

When urine is discharged in too large quantities, it occasions dryness, less free passage of the humors through the small vessels, great heat and thirst, crudities, sinking of the spirits, leanness, and a consumption, and such like accidents. And too much sweating hath almost the same effect. When urine is suppressed and stopped, it distends, corrodes, and putrefies the bladder, ureters, pelvis, and kidneys, and makes all the lymph of the blood of an alkalious acrimony; and by offending the small and tender vessels of the brain, produces uneasiness, stupidity, vertigo's, and apoplexies.

Too great perspiration occasions weakness, fainting, and sudden and unexpected death. But if too little or stopped, the extreme vessels in the skin grow dry and perish, and so the greater excretories being obstructed dry up; then circulation is altered, sharp humors are retained, crudities, putrefaction, fevers, inflammations, and impostumes ensue.

If cold things be applied externally, they stop the pores, contract the fibres, repel what is therein contained, hinder transpiration, and produce the same symptoms as follow an obstructed perspiration. But hot things open, relax, and promote transpiration, and encourage the motion of humors towards the skin, though they dry, by exhausting the thin humors. Moist things wash away the excrements, open and relax the mouths of the vessels, and, if in too great excess, do harm, and produce the same distempers as too much sweat; dry things do just the contrary. From whence we may learn the use of baths, fomentations, and external applications, if we know the qualities of the ingredients, and the manner, season, and duration of their application.

But there are some internal dispositions in the body, so general, that a great many distempers depend upon them, as their causes; therefore in enumerating causes



in general, they are usually proposed, and explained by their causes; such as a *Plethora*, *cacochymia*, and heterogeneous things received internally, which are preternatural

A *Plethora* happens in the body, when the viscera, concerned in preparing chyle, are strong, the blood vessels loose, and a plentiful and good diet is used, in persons of a middle age and of a sanguine disposition, also in the winter time, and summer, and in a moist air, especially in those that are given to ease and indolence, and have lost some of their limbs. It may also be occasioned by excessive heats or motion, extending the greater vessels, and thereby compressing the less, so that upon the least occasion, there is a laceration or breach of the vessels, and a suffocation in the liquids, for want of room, with a sluggishness and unaptness of motion.

*Cacochymia*, or an ill habit and disposition of humors, may be considered, either in those things which externally happen to the humors, or those which are internally added to them; and again, either in all together, or any one humor single.

If then the humors happen to move too briskly through the vessels, that causes a compression, attrition, and attenuation, too much heat, an inflammatory disposition, and the accidents that attend it; but their too slow motion hath the effects beforementioned, when the blood is in that state. In the first place, an erroneous and vitious motion of the spirits, either in excess or defect, is dangerous, offending all the degrees of concoction, secretion, and excretion; from whence proceed a variety of all sorts of distempers.

Also too great fluidity of the humors occasions too much exhalation and consumption, an uneasy and troublesome secretion, a constriction of the greater vessels, and an emptiness in them, which produces weakness, and, in the less vessels, obstructions, ruptures, and suppurations; and it is more especially hurtful, if great acrimony and motions are also present.



Too great tenacity and visciduity creates obstructions, extenſions of the veſſels, pain and tumor, eſpecially amongſt the glands and arterial plexus's. But if acrimony be joined to that viſcoſity, then, according to the different proportion of theſe two, the veſſels are greatly deſtroyed, the humors being thrown out, there enſue pimples, inflammations, gangrenes, ſphacelations, cancers, ill natured ulcers and caries ; but ſometimes acrimony is joined with a viſcous humor, and ſometimes follows upon it.

Crude acid humours, acrid acids, and vinous fermented acids, or chyle, or milk of that quality, volatile and fixed alkalies, or real alkalies ; alſo ſea-ſaline bodies, or ammoniacal ſharp oily aromatic ſalts, or inſipid oily ſubſtances, occaſion the like diſeaſes.

Yellow, vitelline, or leeky, eruginous bile, is bred by too much motion and digeſtion, convulſions, and paſſions of the mind, or the ill diſpoſed humors before mentioned, mixed and fermented in all the actions of the body, along with the natural juices, and this occaſions a great many bad diſtempers, as loathing, and averſion to food, uneaſineſs, hickups, heart-burn, vomiting, iliac paſſion, cholic, gripes, wind, rumbling in the guts, diarrheas, dysenteries, acute diſtempers, fevers and convulſions.

Black choler, called ſo from its color, and the place where it is bred, ſometimes hath the ſharp biting taſte of vinegar, and ſometimes of putrefied blood, and corrodes, burns and diſſolves, occaſions inflammations, gangrenes, ſphacelations, moſt acute pains, and irregular ferments. In the cauſes of diſeaſes it is deſcribed to be of three kinds, Firſt, the mildeſt made only of the pure part of the blood, too much digeſted and aduſt, as 'tis called. Secondly, when this is higher digeſted and exalted by ſtronger and frequent fermentations, and often circulated. Thirdly, when it is made of choler, over digeſted, and too frequently fermented by circulating often.



or is made of yellow, vitelline, or leeky bile ; the effects of which are different, according to the temper thereof, and the nature of the part it falls on.

The blood also, with the serum and the bile, if a predominant acid, alkaly, oyl, or earth, reside therein, produce the distempers before said, to arise from such qualities. The blood, serum, and urine, form stones compounded of a volatile spirit, salt, oyl, and earth, united into a particular form; and these increasing in bulk weight and motion, compress the neighbouring parts; and the vessels containing such stones, by the motion and compressure of its substance, against hard and rough parts, are rubbed and worn out. This stops the passage of the humors, and causes pain, inflammation, ulcers, gangrenes, callosities, and such symptoms as depend upon them.

The eggs of insects, mixed with air, drink and food, and taken into the body, and mixed with phlegm bred in the guts or feces, or lodging in the cavities, and being at rest, and cherished with heat, produce round, broad, or small worms, called *Ascarides*, and the same, sometimes, are swallowed along with what we take, and growing there, continue in the body ; and these by corroding, sucking, and irritating the parts, and consuming the chyle, not only stimulate the nerves, and wound the solid parts ; but produce loathing, horrors, heart-burning, vomiting, swooning, leanness, and a voracious appetite, called *Fames canina*, a tumor of the belly, and the like, but, especially, wind and sudden swelling.

The external or internal force of bodies, in motion, hurts the most simple parts of our body, in all their mechanic actions, as far as we know. And these effects can neither be referred to heat nor cold, moisture nor dryness, to chymical principles, nor acrimony, acidity, nor alkaly. And we find, that other causes, less visible, and very little known, do act and produce diseases, especially in the similar parts.



The matter of a distemper lodged in a disordered part, and suddenly collected, is called a flux, but if slowly brought thither, a collection; the cause of which is, the indisposition of the solid part, not altering or expelling that which began to be formed and assimilated, or the disorder of peccant matter transferred from other parts, and settling there. This translation, fluxion, or attraction, as the ancients called it, is made by motion, heat, pain, and digestion of that humor; and hence arise those distempers which are said to be attended with matter.

Poysons, the plague, or contagion, being admitted any manner of way, offend the solid or liquid parts, or both, so that the course of the vital humors is stopped; these always act by a mechanic force, indeed, but seem scarce explicable without the principles of chymistry. They easily hurt the solid parts, by greatly dissolving, relaxing, binding up, and obstructing the solids, and deprave the liquids by thickening, or comminuting them, or making them sharp, so that they both corrupt by this united force. Most things, therefore, that are exceeding active, force into the nerves, lungs and blood, and act thereon, by a way and manner not hitherto taken notice of, nor understood, so that distempers, thus formed, were called by the ancients, distempers of the whole substance hurt and damaged.

But there are some particular causes of distempers worth taking notice of, since they owe their origin to an ill conformation and structure of the parts; these are primarily owing to the imagination of the mother, the imprudent action of the midwife, or the negligence of the nurse, and carelessness of the guardian; for the little tender body being bound, pressed, squeezed, and driven into an ill shape, which cannot easily be altered, grows deformed; and the indisposition of a thick and sharp humor often does the same in a great many respects.

The causes also of the cavities being vitiated in parts ill disposed are very plain, whether we consider them



as external or internal; and a corrosion of the vessels by external force is often the cause by distension and acrimony. From whence all other accidents of this kind may be understood. A strong pressure, a violent distraction, or drawing asunder of the ligaments, or misplacing of the containing membranes, or a dissolution, produces luxations, or dislocations, ruptures, or falling down of the parts; and things that cut or prick, press with violent force, corrode, burn, distend, bruise, or break, are chiefly the causes of a solution of unity.

From all which it appears, that it is not bitter, sweet, fowre, or acrimony, or any other quality that makes distempers, but their being too predominant, and an excess of any one, above the just quantity, altering and depraving the natural temper of the humors, so as to make them unfit to circulate through the vessels properly belonging to the respective body, and respective part.



## C H A P. V.

### *Of the symptomatic Part of Pathology, or the Effects of Diseases.*

**T**HAT which appears preternatural in a distempered body, and flowing from the distemper, as from a cause, shews itself so, that it may be distinguished from the disease itself, and the proximate and immediate cause thereof, is called a symptom of that disease; but if, for the same reason, it flow from the cause of the distemper,



distemper, it is called a symptom of the cause ; but when it proceeds from some other symptom, as from a cause, it is called a symptom of a symptom. But that which happens upon a disease from a different origin, from that which preceded, or first appeared, may rather be called an accessory disease, which joined with the former, makes a complication of distempers.

From whence it appears, that these symptoms which, at first, only proceeded from the distemper, as their cause, again become distempers themselves, in number, variety, and effect very different, yet commodiously applied by the ancients to perverted actions, the faults of things retained, and excrements, and the altered qualities of the body.

The first class of these is digested, according to the series, or order of the actions diminished, abolished, increased or depraved ; whence they first begin with the symptoms of the appetite to meat or drink : And thus the first degree is, that of appetite diminished ; the next appetite lost ; thirdly, a *Nausea*, or an abhorrence of food ; fourthly, an increase of it above what is natural ; fifthly, a *Pica*, or insatiable appetite, for what may be digested, or is not fit to eat.

The causes of these symptoms are commonly phlegm, which is viscid and hard, want of bile, or the saline humor, a relaxed state of the fibres, or a palsy, filth collected from any putrid substance, a watry disposition of the blood, fatness, or idleness, acrid, acid, saline, choleric, or black bilious humors laid down in the stomach and guts, worms, the strength of the fibres, or continual motion ; a sharp humor being predominant, and not to be appeased without continual swallowing of food, the course of the blood changed, a depraved imagination, especially in women with child. An unsatisfied desire of drink, and an extravagant thirst, uses to arise from too much dryness, or the thickness of the humors being too great to pass through the salival vessels ; from too much heat, or an acrid, muria-  
tic,



tic, or ammoniac, alkaline, aromatic, or oily, burnt salt, or from poisons.

Chewing is hurt, by the faults of the mouth, tongue, teeth, jaws, saliva, or muscles, which may be occasioned by wounds, inflammations, palsies, spasms, or dryness. Swallowing is also prejudiced by the faults of the mouth, tongue, palat, especially that part which is pendulous, also by the tonsils, uvula, larynx, pharynx, esophagus or gullet, and the upper mouth of the stomach; and this may happen by wounds, inflammation, pain, tumors, spasms, palsies, or dryness, cartilaginousness, or by a dislocation of the parts of the larynx, or the *Vertebrae* of the neck; or lastly, for want of mucus to render the parts slippery.

The first species of the action of the stomach hurt, are *ἀπεψία*, or want of digestion, *δυσπεψία*, or difficulty of digestion, *βραδυπεψία*, which is a greater degree of indigestion; and *διαφθορά*, which is a corruption of the food in the stomach, occasioning nidorous, or acid belchings; when these happen, the causes are much like those of a loss of appetite, together with a great deficiency and unactiveness of the saliva from the mouth, and in the stomach, the languid motion of the organs of respiration, filth in the stomach, or worms; quick digestion, if good, is seldom a distemper, but if too great, the cause appears from that of too craving an appetite.

The faults, in the expulsion of the contents of the stomach, are the hick up, loathing, vomiting, *Cholera morbus*, and belching. The first of which, as it seems to be a convulsion of the esophagus, drawing the stomach, and the diaphragm upwards, whilst, at the same time, the latter is suddenly and violently twitched downwards, the cause of it is reckoned to be the quick swallowing of too much food, or the quantity of what is contained in the stomach, acrimony remaining therein, inflammation of the gullet, stomach, or diaphragm, convulsions from too great evacuation, or the excess of vomiting, and from strong poisons.

Loathing



Loathing and vomiting seem to be two retrograde, spasmodic, or convulsive motions of the muscular fibres of the gullet, stomach and guts; and also strong convulsions of the muscles of the abdomen, and the diaphragm; when they are moderate, cause a heaving or loathing, but when more violent, a vomiting. And these proceed from too great a quantity or an acrimony of the contents of the stomach; also from poysons, the brain hurt by wounds, contusion, compression, or inflammation; likewise from an inflammation of the diaphragm, stomach, intestins, spleen, liver, kidneys, pancreas, and mesentery; again, from an irritation and tickling of the palat; or a troublesome and disturbed motion of the spirits by unusual tossings in a coach, ship, &c. or by the idea of something that hath often caused nausea, or vomiting.

But the violent expulsion of choler upwards and downwards from the stomach and intestins is called *Cholera Morbus*; and is a convulsion of the stomach, which occasions vomiting, and also a strong convulsion of the guts downwards; and so the causes are the same, but commonly more violent, and chiefly comes upon eating of fruit, and heat of the season in the month of *August*.

Belching is an explosive eruption of elastic matter, compressed by the convulsive contraction of the fibres of the gullet, stomach and guts, which ceases as soon as those are free; this proceeds from crudities, putrefaction, acid humors, fruit, new wine, fermenting liquors, poyson, convulsive distempers, or a great deal of acrimony.

The expulsive faculty of the intestins and stomach, is also hurt in a lientery, which is a quick expulsion of the food by stool, and whatever is contained in the stomach, without being altered by digestion, the cause of which is the unactiveness of the humors, as in want of appetite and digestion, the stomach and intestins being very much relaxed; yet respiration is strong enough.

If



If chyle be discharged along with the excrements, it is called the celiac affection, the cause of which is the stomach being strong enough, and the humors that flow from it, whilst the intestins are too much relaxed, or the mouths of the lacteal vessels are, by some means or other, obstructed.

A diarrhea is a continual, or frequent and plentiful discharge of thin excrements by stool, proceeding from meat and drink, or a plentiful quantity of other liquors, laid down, some way or other, in the guts. The cause is a sharp humor twinging the intestins, and pressing out fluids from the hepatic, pancreatic, mesenteric and intestinal vessels, the mouths of the mesenteric veins and lacteals being obstructed, the fibres of the intestins very much relaxed, and the excretions, by that means, hindered.

A dysentery is a diarrhea attended with considerable pain, the matter being the same with that of a diarrhea, but sharper; to which are added choler, serum, blood, the mucus, or slime of the intestins, matter, sanies, black choler, small pieces of fibres, caruncles and membranes. So that it hath the same cause, only more violent, which is often the acrimony of some humors, an inflammation, an ulcer, a gangrene of the intestins, or parts thereof, that lay down and discharge their filth herein.

The iliac passion, is a violent discharge, by the mouth, of those things which are taken as aliment, or medicines, or chyle, choler, serum of the stomach, pancreas or intestins, black choler, slime, matter, ichor, excrements out of the intestins, and glysters themselves. The proximate cause of this symptom always seems to be the inverted motion of the fibres of the intestins, stomach and gullet, a violent provocation to vomit, being added as an accessory cause, but the more remote cause is inflammation, a rolling of the guts, an aposthume, schirrus, a cancer, hard excrements, the stone, a rupture, or convulsions of the intestins; from whence the retention



tion of hard excrements, is understood in its origin, cause, nature and effects.

If the generation and separation, or excretion of choler into the intestins be hurt, the symptoms that follow are, the jaundice, a choleric indisposition, stones and tumor of the liver, obstructions, which occasion white, hard, dry excrements; a loss of appetite, and indigestion of food, an imperfect mixture of what is taken into the stomach, a tympany, or dropsy. The cause commonly is an inflammation of the liver, with dryness and obstruction, a thickness of its humors, and of the viscera of the abdomen.

If the lymph of the pancreas, liver or guts is damaged, or hurt, either in its preparation or motion, the like symptoms appear, and proceed from the like causes.

The change of the blood in the heart is its reception, stay and expulsion, which, if they are too quick, as to motion, occasion hot, strong, burning fevers; but if the stay there be longer, and the expulsion weaker, then the strength languishes, and *Polypus*'s breed, or phlegm; the blood is cold, and occasions dropsies, and a great many such like distempers.

When the action of the lungs is hurt, as well that of respiration, as that of transmitting the blood, it consists, first, in the increase or decrease of its efficacy upon the blood; from the first, arises a hot disposition; from the last, an impediment in perfecting sanguification and nutrition, from whence proceed a cachexy, an atrophy, phthisis, and a great many more bad distempers. The cause of that action, being hurt, occasions a fault in a great many organs, which serve to the action of respiration.

The principal symptoms of the secretion of urine being hurt are, first, an *Ischuria*, or a total retention of urine, without any separation. The primary causes of which are a *Plethora*, an inflammation of the kidneys, ureters, or bladder, or its neck, or of the *Urethra*; also



to a spasmus, or violent contraction of those parts ; a pressure, or an obstruction by a stone, phlegm, or matter, or by caruncles, apothumation, or tumors.

The second is *Dysuria*, that case, when water is made with a great deal of trouble and difficulty, or pain ; of which species is that we call the stranguy, where the water is made drop by drop, with a sense of burning heat. The cause of both is manifold, as first, the acrimony of new fermented beer, or wine, or the dreggs of either ; also acid acrimony, salt things, and those that are alkalious, oily, aromatic, choleric, and such like humors ; likewise the excoriation of the parts of the bladder, or *Urethra*, by inflammation, or an ulcer, by the fretting of the stone, the assumption of burning hot insects ; also the passage being stopped by a stone, or tumor in the neck of the bladder, or in the *Urethra*.

It is called *Incontinentia Urinae*, when it flows out without the consent of the will, or the force of respiration ; it is occasioned most commonly by the fibres of the sphincter muscle of the bladder being relaxed, dilated, or separated by cutting, consumed by suppuration, or putrefied by a gangrene.

The *Diabetes* is when the person makes chylous or milky water often, and in great quantities. The cause of it is reckoned to be too great a relaxation of the ends of the arteries in the kidneys, as well as the emissary vessels that pass to the *Pelvis* ; the humors being also much diluted, which are both occasioned, and produced by watry fluids.

The vital action, being hurt, respects the pulsation of the heart as a symptom, or the action of respiration, or both together ; so that, first, the palpitation of the heart is to be taken notice of, which is its violent contraction, together with the great resistance of the blood driven out of the heart. The cause of it, for the most part, is the violent and inordinate force of the vital spirits driven into the fibres of the heart, as in violent passions of the mind, sudden fear, the hysteric passion ; in sudden



sudden and violent motion, sudden waking, and sometimes the fibres of the heart are stimulated, by a corrosive; sharp matter, as in a cacochymia, or ill disposition of the blood, put in agitation, or by an inflammation of the heart, *Pericardium*; or these being distempered by a stone, worms, hairs, or an aneurism, or by thick blood, a polypus; or too great a quantity of blood; lastly, by arteries grown cartilaginous, or bony, or obstructed at their extremities.

An intermitting pulse happens either thro' default of the spirits from the *Cerebellum* not flowing regularly into the heart, or of the vessels that send blood and humors; or lastly, when the humor is vitiated, which flows thro' the vessels; then the causes of this symptom are different, as convulsions, a polypus, a phlegmatic ill habit of body, an inflammation of the arteries, lungs, or heart, a deficiency of blood, bony arteries, or cartilaginous, an aneurism, or stopped by a stone; or the heart being ill affected different ways.

A short thick pulse depends on a quicker systolic contraction of the heart, and this, on a more frequent influx of the spirits from the *Cerebellum*, and a more difficult progress of the liquor to be expelled, which is occasioned by sharp humors, or obstructions.

The diminution of the pulse, or its total cessation, is called *λειποθυρία*, when so deficient, that the strength being wholly weakened can scarce sustain the body; or when this weakness is so much increased, that the natural heat begins to decay, it is termed *λειποψυχία*; but *συσκοπή*, when the heart is so deficient, that heat, motion and sense are almost lost, and cold sweats ensue; when all those being sensibly abolish'd, or as to perception, the person seems altogether dead, 'tis called *ἀσφυξία*. The cause of these symptoms are various, and appear in different degrees, like those which shew themselves in an intermitting pulse; as the ideas of something horrid and terrible, being with child, passions of the mind, convulsions, some kind of evacuations, especially large dis-



charges of blood in wounded persons, in the time of birth or miscarriage, and in cancerous bodies.

The symptoms that attend a faulty respiration are, first, ἀσπνοια, when breathing wholly ceases, and hath the same causes as the pulse diminished, just now mentioned; to which also a vitious air concurs, venomous, caustic, acid, or austere vapors and exhalations, the palsy, or convulsions of the organs serving to respiration, or other distempers which destroy the functions, or actions of these parts.

*Dyspnœa*, if when respiration is performed with uneasiness, pain and fatigue, and is produced by the same causes as the former, but slighter; to which also the ill conformation of the breast will contribute.

An asthma, is a frequent, troublesome, wheezing respiration, rising commonly from stronger causes than a *Dyspnœa*; but chiefly from the convulsive contraction of the muscular fibres in the lungs.

An *Orthopnœa*, is a troublesome and difficult breathing with snorting, and can only be performed when the neck and breast are placed right upwards; the causes are the same as before, but come and return variously.

A suffocating catarrh, suddenly terminates in an *Aspnœa*, breath being totally stopp'd, and hath the like causes as an *Orthopnœa*; to which we may add, the frequent discharge of thin humors into the jaws and lungs, and the great fault of the nerves, as in hysteric cases; it may be also occasioned by a polypus in the heart, suddenly thrust into the lungs.

But all these symptoms are commonly produced by very remarkable causes, which appear in dead bodies opened, or the discharge of the matter; as first, a fulness of the thorax, by extravasated lymph, matter, or blood; also an inflammation of the larynx, the wind-pipe, or its smaller ducts, or of the lungs, *Pleura*, *mediastinum*, *diaphragma*, *pericardium*, or the muscles serving to respiration, and those of the abdomen; also matter  
of



of different kinds, as polypous, phlegmy, chalky, stony, or purulent; and likewise tumors about the larynx, in the lungs, or thorax, which become inflammatory, suppurate, grow schirrous, or cancerous, or have a broad adhesion of the lungs to the *Pleura*.

But besides the causes hitherto enumerated, we may observe, that the inside of the lungs, which convey air backwards or forwards are constantly supplied with a moisture to keep them from drying, that cannot be discharged, but as it is imbibed into the pores of the air, and carried out of the lungs that way; but if, instead of the just quantity, too much be separated in those parts, and more than the air can imbibe, or drive out when rarified, then the superfluous quantity must needs clogg the canals of the lungs, and create an uneasiness in the parts, and hurt, or obstruct, the free passage of the air; which, as it happens in greater, or less degrees, will occasion many ill symptoms, and most of those just now mentioned.

The symptoms of the sight damaged, are very numerous, but distinguished by reckoning up their causes, according to the different places where they happen: and first, the parts containing the ball of the eye, or its bulbous part may be hurt, by pressure, protrusion, being thrust out, or corroded, by inflammatory, or schirrous tumors, apostems, cancers, exostoses, or, caries of the bones forming the orbit of the eye; by which means the figure, humors, space, axis of vision, and the collection of the rays, in a due place, may be depraved.

The eye-lids also being inflamed, suppurated, or swelled, growing together, or rough, disturb the sight, for several reasons, especially when the glands are disorder'd; for the whole eye presently grows dirty and dull, and so prevents the humors.

Tears also abounding in quantity, or becoming too sharp, or thick, flowing to the borders of each eye-lid, and running down upon the cheeks, occasion a very



troublesome wetness, and produce inflammations, corruptions, dimness of sight, and *Fistula Lachrymales*, the lachrymal gland being too much relaxed; or these inconveniences may also be promoted by too much motion, and the acrimony of the lachrymal humor, or by the ill figure of the eye-lids, especially that part called *Tarsus palpebræ*, or by the ill habit of the angular caruncle, or the bad and various disposition of the mouths of the eye-lids, which absorb and drink up the tears, and of the pipes which carry them into the lachrymal juice; and according as it varies from its natural temper; also the canal leading to the nose, or the membrane which covers the inside of the nose being disordered, and hindering the discharge of that humor into the cavity of the nostrils; all concur to produce the before-mentioned symptoms.

But vision is depraved, hindered, or destroy'd, when the *Tunica Cornea* and *Adnata*, are hurt by obscurity, growing white, thick, or edematous, or become affected with inflammation, a hardness like a nail, a fleshy substance, a pearl, covered with a cartilaginous body, cicatrix, or white film, which may proceed from various causes.

Also when the aqueous humor is deficient, the eye wastes, and the *Cornea* is wrinkled; if it be too much in quantity, the eye grows monstrous and large, and what is called *Oculus Elephantinus*; if it stagnates and is not renewed, it putrefies and destroys the whole fabric of the eye; if it acquires a color, it thickens into a slime or phlegm, and occasions suffusions and cataracts, of a different color from the eye. These accidents commonly happen betwixt the inside of the *Uvea*, and the crystalline humor, and are occasioned by inflammation, and an ill habit of body, or the imprudent application of coagulating remedies.

If the *Uvea* be inflamed, it occasions a very painful *Ophthalmia*, which soon grows dangerous to the sight; if it suppurate, the sight is lost; if immoveable and contracted,



contracted, it occasions an *ἡμεραλωπία*, so that the person can only discern by day; which happens also when a small cataract is thinner at the edges, and thicker in the middle; if it be immoveable, and very open, it occasions a *νυκταλωπία*, or a disposition only to see by night, or in the evening.

When the crystalline humor is dark, inflamed, suppurated, hydropical, corrupted, or wasted, it produces a distemper called *Glaucoma*, from the color of the humor, a cataract and darkness of sight. But if the figure, bulk, thickness, or thinness be altered, it produces a great variety of accidents. If the figure be too spherical, and presses out forwards, and the pupil be small, with a great many other circumstances, not yet exactly observed in the length of the eye, and in the crystalline humor, and its situation, it occasions a *μωπία*, or purblindness in various degrees; but if it be smooth and plainer, according to the different dispositions of the humor, and its situation, it produces *πρεσβυωπία*, or sight that is best at a distance.

The vitreous humor being subject to the like defects, or accidents, affords the like *Phænomena*.

The variety of the vessels in the *Retina*, make it liable to abundance of accidents, as a dropsy, *Oedema*, *phlyctæna*, inflammation and compression; and the optic nerves and membranes, that involve or encompass it, are liable to the same distempers, as also a tumor, *Steatoma*, abscess, watry eruptions, stones, inflammation, consumption, corrosion, corruption, obstruction, which so happen, so as to hinder a free communication betwixt the optic nerves and their origin in the medullary part of the brain, or quite abolish it; all these will variously represent images of flakes, sparks, or darkness; which is called *Gutta serena*.

Also a contraction, or palsy of the muscles of the eye, wounds, ulcers, inflammation, or pressure, may occasion rye-looks, squinting, or gogling, and many other depravations of the sight.



The membrane called *Chorooides*, *Ruyfchiana*, and the *Uvea*, being plentifully supplied with blood-vessels, are subject to inflammation and suppuration, and may occasion a glimmering called *Choroidea*, and from different distempers happening in various parts of the eyes, a great variety of accidents may be produced, as false sight, confusion, dulness and blindness.

The chief symptoms, that happen in hearing, are, its increase, decrease, loss, or depravation.

In the acutest distemper of the brain, nerves and membranes, these being too much stretched, there often happens a very brisk sharpness of hearing affecting the brain very strongly with the least sound, which sometimes occasions convulsive motions.

Thickness of hearing, or *Gravis Auditus* happens when the perception of the sound is less than it ought to be in health, which rises from a great many, and very different causes, most commodiously to be reduced, according to the variety of the places affected; as the external ear may be too plain, or taken away; the auditory passage may be too streight, or narrow, obstructed with some tumor, insects, matter, dirt, or wax too much hardened; or if the membrane of the *Tympanum* contributes to hearing, that may be hurt by being too loose, dry, or callous, or may be made too thick, a spongy, fungous crust sticking to it; the shell-like cavity within may be filled with a thin *ichor*, matter, or phlegm; with tumors of the membrane that encloses it on every side, or with dust falling into it when the membrane is broke, or when the *Eustachian* duct is partly, or wholly obstructed; or else when the bones are separated from their union, and often thrust out of the meatus or cavity, the membrane that tied them together being suppurated, as it often happens after excessive pains of the inward parts of the ear, or for want of those bones, when the parts are ill formed; it is also often occasioned by a dryness, relaxation, or too much thickness, or a superfluity of moisture, too much tension, the membrane being too much stretched



stretched, corrupted, corroded, or hardened ; and this membrane is called the membrane of the round, or oval perforation ; it may also be caused by the various faults of the *Vestibulum*, labyrinth, or the cavity of the *Cochlea*, or the *Meatus* of the *Os petrosum* being inflamed, obstructed, or become paralytic, and by such things as flow from these, as their causes ; as also by their ill structure, that renders them unfit to act in conveying the sense of hearing ; lastly, it may be occasioned by any thing that is an impediment, or hindrance to the soft auditory nerve from its entrance into the *Os petrosum*, even to the *Medulla oblongata*, or from thence to its origin in the medullary part of the brain, as by inflammations, tumors, exostoses, or the action of the brain being hurt, and numberless other actions ; from whence appears the difficulty of performing cures in this case.

The hearing may also be depraved thro' default of the external air being very moist and cloudy, or the internal air not being able to pass freely in, or go out. And here the distempers of those small arteries frequently arise, they being dispersed every where through the membranes of the whole organ of hearing ; which easily shews us the reason of tinkling, or a rumbling noise, a reverberatory sound or whispering.

If all these disorders mentioned grow, increase, and continue long, they produce a perfect deafness, and ignorance, or forgetfulness of speech ; the cause of which is often the growing together of *Eustachius's* tube, the jaws being corroded by the venereal distemper, when the raw edges thereof adhere and unite.

The sense of smelling is either diminished or lost, *first*, by the defect or solidity of the four spongy bones, or the cavities in the *Os frontis*, the upper jaw, and the *Os cuneiforme* ; *secondly*, by the dryness, or too much moisture of the olfactory membrane, or its inflammation, suppuration, or gangrene ; *thirdly*, When the olfactory nerves are compressed by any kind of tumors in this part, exostoses, or a *Polypus* ; *fourthly*, by faults in the brain, at



the origin of the nerves, as was said of all the senses; it is also depraved by the fetidness of any matter lodged in the cavernous cells, and continually affecting the sensory with their exhalations.

The taste is diminish'd, destroy'd, or deprav'd; it is either diminished or lost, when the nervous *Papillæ* in the tongue are covered with a crust, dirt, slime, pimples, small skins, pustles, or warts; also by inflammation, drying, or by the nerves of the fifth and ninth pair being hurt. It is depraved thro' fault of the most predominant humor, which commonly is in the saliva discharged into the mouth, which being depraved occasions a choleric, alkalious, acid, saline, eruginous, oily, sweet, or rotten taste, as if the food taken into the mouth had those qualities.

The touch may be hurt, by a numbness that scarce perceives, or but very dully, as if something was interposed betwixt the part and the object, which may be caused by the coldness of the organ or nerve, or some disorder in the brain; or else by the interposition of something betwixt the object and the sensory. It may be also too quick for want of the interposition of the cuticle to cover the nerves, or by too much extension and tenderness of the instrument. When quite lost, it proceeds from any cause that renders the brain or nerves unfit to perform their office, as in an apoplexy or the palsy.

Watchfulness and inability to sleep proceeds, *first*, from too great a determination of the spirits to the organs of sense; *secondly*, from their too quick return to the brain, the lower parts being obstructed by cold, or some other cause, as in hypochondriac, melancholy and mad persons, whose lower parts are cold; *thirdly*, from any thing irritating, which twinges the organs of sense, especially the brain; *Fourthly*, by too much motion of the humors, the ducts of the brain being yet open; *fifthly*, by distempers in which the before-mentioned qualities are predominant, as in fevers, a phrensy, melancholy, pains, suppurations, and the like.

Too



Too great disposition to sleep, arises from every cause which hinders the flux or reflux of rightly disposed spirits in a sufficient quantity, from the medullary part of the brain through the nerves to the organs of sense, and the muscles serving to voluntary motion, and from those to the origin of the nerves in the marrow of the brain; and this cause is very manifold, but may easily be referred to a *Plethora*, obstructions, effusion of the humors, compression of the vessels, inflammation, suppuration, gangrene, slothfulness, a collapse upon emptiness, the use of opium, narcotics, spices, fermented spirits, applied too much to the nostrils, or taken into the body, hard or fat meat staying long in the stomach, and eat too plentifully.

A *Coma vigil*, or an insuperable propensity to sleep, with a perpetual waking from terrible dreams, besides the forementioned causes, proceeds from a violent stimulation and twinging, attended with a great inflammation. A *Coma somnolentum*, is a long continued sleep, with a quick relapse into it when waked; it hath mostly the same causes with the former, but more violent, and to a higher degree. A *Carus* is a profound sleep, with a sudden loss of sense and motion, an acute fever, and a great difficulty in being waked out of it. A *Lethargy* is a profound, quiet sleep, attended with forgetfulness, from a slow and cold cause, but much like the causes before mentioned, and often rises from the concurrence of a great many such; a-kin to which is that called *Cataphora*.

*Anaesthesia*, is a total loss of the faculty of perceiving the actions of sensible objects on the external organs of sense; the several degrees of which are, stiffness or numbness, dulness and confusion; the memory abolished and confused; the judgment staggering, lost, and disturbed; with raving, foolishness, madness, and a depraved imagination; with all the distempers that come under these. They depend upon a great many and different causes, but chiefly those lately mentioned; among which, age, passions, stiffness or laxity, firmness or solution of the solid parts, and the thickness, acrimony, and sluggishness of the liquids may be reckoned the principal, An



An apoplexy is the sudden and entire loss of the external senses, as well as internal; all voluntary motion, respiration, and the pulse continuing, and being often increased, and the functions immediately depending on the first still remaining. The cause of it is whatever, in the brain, can hinder the flux of the spirits from thence through the nerves, which is manifold, and may be referred to any thing that compresses the brain internally, or externally, as, *first*, fractures, blows, exostoses, tumors, compressions of the skull, whilst tender, in youth or childhood; *secondly*, bloody, serous, purulent, phlegmatic, sanious humors, stagnating or extravasated in those places where they may press upon or corrode the brain, and its membranes, as betwixt the skull and the *Meninges*, betwixt those and the brain in the ventricles of the brain, about the *Medulla oblongata*, and the spinal marrow. *Thirdly*, inflammatory, watry, serous, purulent, slimy, fat, schirrous, or stony tumors in those places, and having the same power of compressing the parts. *Fourthly*, whatever hinders the flux of blood to the brain, either the vessels being wounded, compressed, or obstructed by polypous excrescences, or otherwise. *Fifthly*, the like obstructing resistance to the return of the blood in the veins, sinus's, or ventricles, which hindrances proceed from a compressure of the veins.

A palsy, is an incapacity of moving the relaxed muscles, for want of spirits flowing into the fibres of them, or arterial blood into its vessels, thro' a default in the brain, nerves, the muscles themselves, or of the arteries.

A paraplegy, is a loss of the motion of all the muscles under the head, which have nerves from the brain and *Cerebellum* passing under the skull; and, and therefore, the fault is in the fourth ventricle of the brain, or at the beginning of the spinal marrow.

An hemiplegy, is the same kind of disease, but only on one side of the whole body; so that the fault is only on one side of the brain, or spinal marrow. From whence the palsy of any part may be easily understood, and why



why there is a paraplegy in an apoplexy, or a strong hemiplegy; also why, when an apoplexy ceases, one of these follows, and continues a long time.

The epilepsy, or falling sickness, is a sudden and total loss of external and internal senses, and of voluntary motion with violent and reciprocal convulsions; where two causes appear to concur seemingly opposite, partly that of an apoplexy, and partly of a continual waking, or *Coma vigil*, acting by turns, but neither of them so strong, nor of so long continuance.

A vertigo, is, when objects seem to turn round, with a staggering motion of the limbs; the causes are the same as in an apoplexy, but gentler.

A spasmus, or convulsion, is a violent and involuntary contraction of the muscles, with a motion of the parts whereto the muscles are connected; the reason of which is the violent and continued reflux of the nervous juice into the muscles; but the causes of this are various, being either in the blood, the arteries, the membranes of the brain, the brain itself, the nerves, muscles, or skull.

*Tetanus*, is a stiffness and involuntary convulsion of the muscles proper to bend and extend the part at the same time, which is either universal, of them all together or particular, of any one member.

*Εμπροσθεν* ⊙, is a convulsion of the muscles which bend the head, neck, thorax, or loins forwards. *Οπισθεν* ⊙, is a convulsion of the muscles, which bend the head, neck, or back, backwards, and is easily discovered, because the reason of these is the same as of a spasmus, or convulsion, but more universal, and almost always very subtil, sharp, and venomous. From whence it appears, why a *Vertigo*, or convulsion, especially if universal, the falling sickness, a resolution of the parts, especially if they be great, stubborn, and proceed from an internal cause, commonly end in an apoplexy.

The



The faults of the excrements, and of what is retained, are explained in the causes of distempers before mentioned; an account of which, as to their causes, may be found there; worms, stones, and the like may be also here enumerated.

That quality of a body is said to be vitiated, or depraved, which hurts a sensible disposition, but this chiefly relates to scent and color.

A pale, yellow, green, livid, red or black color of the skin, cuticle, of the coat of the eye, called *Adnata* and *Cornea*; of the lips, mouth, tongue, jaws, and the caruncle of the eye, depends on the like bodies shining thro' the transparent ones, and as they meet one another in different degrees and order, they are referred to different causes, as appears in an inflammation, gangrene, sphacelation, &c. The paleness, redness, yellowness, brown or black color of the bones, proceed from inflammation, abscesses, depraved marrow, the loss of the *Periosteum*, a caries, or *Spina Ventosa*. A fetid scent arises from a stagnation, effusion, corruption of the humors, or their being rendered poysonous; and also from any cause that too much attenuates the salts and oils, and renders them volatile, as fasting, heat, excessive motion, or too great acrimony of what is received.







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PHYSIC.

CONTAINING

The Diagnostics and Prognostics, or the Knowledge of the Signs and Events of Diseases.

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PART III.

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CHAP. I.

*Of the Semeiotics, in general.*



SINCE a disease is an effect depending upon its cause, it is a particular thing, distinct from all others, and, therefore, to be accurately known in its proper and particular nature, that it may be cured. The same is to be understood of health, and its various states.

The present nature, either of health, or its defect, a disease, seldom offers itself to the senses, as it really is, and,



and, therefore, of themselves they cannot be so conspicuous and clearly known, when present in the body; nay the reason of both often lies concealed

But when either of them are present, there are certain effects depending on the exercise of healthful actions, or those that are vitious and distempered; these, indeed, are distinct from the causes, yet depend so upon them, that they shew their disposition; and since they may be discerned by the senses, they greatly contribute to the discovery thereof.

Now the knowledge of the application of a known cause to any part of the body before known, from the physiology, teaches the nature of the effect which flows from thence, whether it be healthful or pernicious. Nor does it much signify whether the cause be external or internal, natural, accidental, healthful, distempered, or mortal.

But the forementioned effects, and those called causes, as they are accounted sensible themselves, or immediately deduced from thence, are called *Phænomena*; and these are commonly termed signs, when by them known to the senses, we can rationally demonstrate the presence, nature, state and event, both of health, diseases, and death.

These are called diagnostics, when they denounce and shew the present condition of a body, whether alive, sound, sick, or likely to die, and near what time. But if they foretel what is to come, then they are called prognostics; but when they recal into our view and knowledge what passed before, they are termed anamnestic, calling into our memory what we should not otherwise regard.

But in the distinction of diseases, that sign which is proper to the distemper, and inseparable from it, as rising from its nature, is called pathognomic. The knowledge whereof is very necessary and useful, and often hard to be obtained, but always attends the distemper, as long as it continues the same, and does not degenerate;



nerate; but it often consists in a conjunction of several concurring signs.

Those signs which teach us the variation or degeneration of a disease, and shew its altered state, are called ἐπιγεγόμενα, or accessory signs; the force of which are so beneficial in the knowledge and cure of distempers, that nothing can be more helpful in practice, and the greatest mischances and blunders happen therein, when these are neglected.

But since all these are effects produced from the cause of a disease, the disease itself, and its symptoms which are continually changing; they, therefore, give the present state and condition of the matter, at every change, either of that which first produced the disease, or that which was occasioned by it, and so are commonly reduced to these three classes, *first*, crudity or concoction. *Secondly*, termination in health, a distemper, or death. *Thirdly*, separation and excretion of concocted matter; and these are, therefore, called, decretory or critical signs.



## CHAP. II.

### *Concerning the general Signs of a good State of Health.*

THESE signs are knowable from the actions of the body, being easily, commodiously, pleasantly, and constantly performed; the three first whereof are easily known, but the fourth is attended with more difficulty; for the constancy is only discovered by those signs which prognosticate the body to be long lived; and these also indicate a good state of health at present.

But



But all those signs of long life are the effects of the whole disposition of the machine, in respect of the solid and fluid parts thereof, upon which the duration of the whole frame depends; and this is an assimilation of the food into the same juices, of which the machine is composed in a state of health.

By diligent observation, these signs may, in *Europe*, be reduced to the following classes. *First*, generation, conception being made in sound parents, who are strong, and of ripe years, and who perform the conjugal act but seldom, and with vigor, and that in a morning after a perfect concoction by sleep; also in the spring-time, and in good weather. *Secondly*, gestation in the womb, the mother being sound and in health, and exercising her body sufficiently; of a calm disposition of mind, and nourishing but one fetus at once, and that with wholesome aliment. *Thirdly*, the birth; happening exactly nine months after conception, especially in the month of *December, January, or February*. *Fourthly*, the manner in which the body grows; as gradually and equally, the increase of its bulk and strength being continued till five and twenty, and beyond that year of its age. *Fifthly*, the habit of body, the thorax being broad and large, the abdomen small and compressed, the shoulders, arms, thighs, and legs, firm, plump, fleshy, and thick set with hair that is strong and bristly; a great and large head, especially towards the *Occiput*, and not before towards the face, the skin being hard; much flesh with little fat. *Sixthly*, the humors, the blood being thick and florid, soon coagulating into a tough mass when out of the vessels, the rest of the humors being plentiful, tenacious, moderately hot, and not too oily or soft. *Seventhly*, the actions, respiration being gentle, large, full, easy, and equal, without any great change in the organ of breathing. The pulse ought also to be gentle, full, equal, strong and constant, and not easily altered. The belly not too loose, but costive, without any detriment; the urine moderate and well digested;



gested ; sweat moderate, sleep sound, equable and refreshing, a good appetite with digestion answerable, ability to labor, a dulness of wit, as well as of the motions of the mind and body, and a perseverance herein, notwithstanding accidental changes.

And if the fabric of the body be fit to perform its actions easily, commodiously and pleasantly, it will appear, *First*, by the testimony of the senses ; *Secondly*, if the signs just now mentioned are present ; *Thirdly*, if the solid parts are strong, firm and springy, as to their matter ; and of such bulk, form, shape, and connected in such a manner, situation, and proportion as are proper for the particular and common motions necessary among the solids and liquids ; *Fourthly*, if the nature of the of the humors be such as is sufficient to perform the intestine, circulatory, secretory, nutritious and excretory motions without any inequality, or its effects : And the most evident sign of this equability and evenness, is the absence of throbbing pulsations, tumors, pains, heats, unaptness for motion and insensibility in the several parts of different bodies ; *Fifthly*, if the soul and body are so joined together that the passions of the mind are moderate and not violent. *Sixthly*, if the color is red and white, or inclined to a pleasant brown, black, the heat moderate, and the body light, as to sense. And, *seventhly*, by there being the greatest power to resist the causes of distempers.

But the greatest power of resisting the particular cause of any one distemper, either venomous or contagious, does not always shew the most perfect health, and *vice versa*, as appears by observation.







## C H A P. III.

*Concerning the Signs of particular Health.*

**T**HE good temper and disposition of any single part is known, if its action be always ready, brisk and constant in producing its effects, as appears from the physiology.

But health is a disposition of the whole frame of a body, consisting of solid and liquid parts; and this is particular to every person, and, therefore, is such only in respect of that particular body; so that different bodies, which vary much from one another, both in solids and liquids, may, notwithstanding, be said to be sound; and this the ancients called *idiosyncrasy*, or the health of the temperament, which, therefore, cannot easily be reduced to proper heads; yet the division made use of by the ancients into hot, cold, moist and dry; choleric, sanguine, phlegmatic and melancholy, are of use in physic.

Signs of a hot temper are said to be, yellow hair, thick and plentiful all over the body, a reddish color in the white of the eyes, and the lachrymal caruncles, great redness in the face, lips and mouth; a nimble, slender, strong body; a large and quick pulse; and anger that is soon over. Also in such bodies the vessels are strong and contracted, and the bowels firm; the humors in brisk motion, thick and sharp, or acrid: they are much refreshed with moist, diluting and temperate things, and hot ones are as prejudicial to them.

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The signs of a cold temper are all the contrary, as smoothness, thin hair, a pale color, a thick sluggish body, weak and cold, and disposed to tumors; a small and slow pulse, weakness of body and mind, and a disposition to fear. The humors are soft, watry, phlegmy and slow, and the solid parts loose and flaccid. Strengthening and warm things are beneficial, and cold or moist ones, that relax, are hurtful.

The signs of a dry temper are much the same as of a hot one, if leanness be join'd with it; the vessels are here contracted, there is little moisture; and that too is almost acrid. Things are hurtful or refreshing in this as in a hot temper; but a moist temper is much a-kin to a cold one, if a tumor be added thereto, in other respects they are, therefore, the same.

A choleric constitution may be known by the large quantity of hair, which is black, or brittle and curled; also by the firmness, leanness and thinness of flesh, a brown color, large veins, a great and quick pulse, boldness and aptness to passion. In these there seems to be a greater quantity of solid than liquid substance, and they seem to be near allied to hot and dry tempers. Hot and dry things are hurtful to such, but cold and moist refreshing.

A sanguine temper is distinguished by the hair growing thinner, of a yellowish white, or brown color, soft flesh, and inconsiderable in quantity; large blue veins, full of blood; a red color, aptness to anger, but easily pacified. Temperate things, and those that make a discharge, are agreeable here; but hot and pungent things are hurtful.

Phlegmatic constitutions have a much smoother skin, white, slender hair, which grows but slowly; their body is white, tumid, soft and fat; the veins are small and scarce appear; the blood vessels seem little, but the lateral larger; they are much like the cold tempers, so that things moist and cold are prejudicial, but hot, dry and strengthening things serviceable.



The signs of a melancholy constitution are smoothness, very black hair, great leanness and dryness, and a color every where black ; they are very diligent and constant, revengeful, and of a very penetrating genius. In this the vessels seem small, strong, and closely compacted ; the humors thick and tough, very well mixed, and not easily altered or changed. Hot, dry and sharp things are hurtful here ; but those that moisten, cool, loosen, mollify, and gently dissolve without sharpness, are wholesome.

This doctrine is of the greatest use in the knowledge of distempers which are likely to arise in any temper ; those of every one being peculiar, and, therefore, to be fore-seen ; and from hence most antecedent causes flow.



#### C H A P. IV.

### *Of the Signs of Diseases, or their Diagnostics.*

**T**HE signs of a future disease are taken, *first*, from the unusual change of any function or action ; especially from the diminution of perspiration, unusual weariness, and dulness or heaviness. *Secondly*, from the knowledge of every man's temper, and the particular structure of his body. *Thirdly*, from the knowledge of the procatartic, or occasioning cause. *Fourthly*, from the knowledge of epidemic distempers which reign at certain times.

The signs of a distemper that is past, are taken from the known effects, which remain after any solid part is hurt ;



hurt; or which follow the depravation of any humor, or actions hurt; for he that compares the use of the parts in health with those defects that remain, will easily know the nature of the disease.

The signs of a present distemper respect its causes, nature, symptoms, state and event. The signs, which shew the nature of the cause, are to be taken, *first*, from the observation of those things, that being applied, or to be applied, occasion distempers; which belongs to pathology; *Secondly*, from the peculiar disposition; and, *thirdly*, from the nature of the effects observable by the senses.

A disease of the solid parts is known, *first*, by the force, quality, and method of application, and the continuance of the cause, whether external or internal. *Secondly*, from the change of qualities, the situation and connection of the part affected. *Thirdly*, from the functions hurt. *Fourthly*, from what comes out of the part affected in a right line, or obliquely. Thus wounds, contusions, corrosions, or burns, with their condition and state are known, *first*, by the sight; *secondly*, by the nature of the part hurt; *thirdly*, by the symptoms. The event is foretold, *First*, from the necessity of the part hurt to continue life or health; *secondly*, from the disposition of the part; *thirdly*, the manner of the hurt; *fourthly*, from the disposition of the sick.

Ulcers, fistula's, schirrosities, cancers, carcinoma's, inflammations, gangrenes and sphacelations, easily discover themselves to the senses, and as they are known by the signs contained in their definitions; and the state of them is easily discovered; *first*, by sight, touch, or smell; *secondly*, the disposition of the part hurt; *thirdly*, from the symptoms; and their events are foretold, *first*, from the known nature of the case; *secondly*, the nature of the part hurt, and the respect it hath to life or health; *thirdly*, from the connection of the parts adjacent; *fourthly*, from the difficulty of applying the means of cure; and, *fifthly*, from the disposition of the body.



But if these accidents lye hid externally, and are not within the reach of our senses, they must be discovered, *first*, from the nature of the cause; *secondly*, from some function hurt at the same time; *thirdly*, from what is discharged; *fourthly*, from the part affected known anatomically, whether external or internal; *fifthly*, from the sensible quality hurt: And their state and event are known by the same indications.

The place affected, whether internal or external, hurt by an external cause, hath commonly those signs which are evident to the external senses, being either wounded, contused, inflamed, or oedematous, ulcerous, gangrenous, sphacelated, dislocated, distorted, fractured, carious, wasted, schirrous, cancerous, or sarcomatous; or by comparing the function hurt, with the origin of that instrument by which the action was performed, when found, which discovers the seat of the malady.

If the place affected be internal, and more difficult to be come at, because from an inward cause; it is discovered, *first*, by the known nature of the cause; *secondly*, by the function hurt; *thirdly*, by the nature of the disease; *fourthly*, by the nature of what is discharged; *fifthly*, by the know symptoms compared with the anatomy of the parts. Thus we discover diseases of the brain, nostrils, jaws, *Thorax*, *Pleura*, *Mediastinum*, *Pericardium*, the lungs, heart, diaphragm, liver, spleen, stomach, *Pancreas*, mesentery, intestins, kidneys, ureters, bladder, *Urethra*, womb, and parts serving to generation.

The signs of acute distempers in the humors are taken, *first*, from the swiftness and violence of the beginning of the distemper; *secondly*, the violence of the symptoms; *thirdly*, the functions hurt; *fourthly*, the excrements; *fifthly*, the epidemic constitution; *sixthly*, the season of the year; *seventhly*, the sex, age, life and temper of the sick person. If these signs are all strong, they shew danger, if gentle they promise well.

The signs also in acute distempers of the fluids, which define and foretel the state, danger, continuance and e-



vent thereof, are known by observing the effects depending on the disposition of the vitiated humors, before laid down.

The signs of acrimony in the humors are, pain, without any indication of motion increased, or any apparent, great obstruction; as also the corrosion of the part without any present tumor. The signs of an alkalious acrimony, are a cadaverous, fetid scent in the whole, or some part; the taste, as of flesh, or urine, putrefied; a black, leaden, or ash-colored erosion that creeps and spreads apace; a great, and almost unquenchable thirst; a loss of appetite, and abhorrence of food, loose excrements, shining, and of a deadly smell, dark colored, or black; sharp, thick, brown, froathy urine, fetid, as if putrefied, and scarce depositing any sediment; very little sweat, or like the urine just described; the outward skin is dry, as also that within the nostrils, mouth, and upon the tongue and jaws; the blood is thin, dissolved, florid, and scarce coagulates; reddish pustles, and full of an ichor, or of a brown, leaden, or black color, and subject to gangrene; buboes, and purple spots; most acute and sudden inflammations, and a sphacelation with blisters; to which signs we may add, that acids are serviceable in such cases.

The signs of acid acrimony are an acid smell and taste, a pale color in the face, corners of the eyes, lips, mouth, gums and jaws; a gentle erosion with paleness; moderate thirst, oftentimes a great appetite and quick digestion; a strong inclination to earthy things and absorbents; griping of the guts, with paleness and cold; white, griping stools, of an acid smell, and green color; urine as in the strangury, white and turbid, with a copious thick sediment; much sour sweat; a loose skin; thick blood, sometimes pale, and sometimes blackish; slight and gentle inflammations; and such things prove serviceable as are opposite to acids.

Signs of a muriatic or ammoniac acrimony, are, a salt taste, a gentle corrosion, an itching which occasions



redness, a great and continual thirst, scarce to be quenched; a dryness and roughness; salt urine, not easily tending to putrefaction, with a thick sediment, and a thin fat scum, like a skin, swimming upon it; in which case watry things are good.

Signs of an oily acrimony are a smell like corruption, a bitter, rancid, fat, sharp taste, like that which comes from oil burnt or putrefied; the jaws burning hot, and of a nidorous smell, like that of rotten eggs; a black hot erosion; loathing, and an aversion to eating, attended with horror; fat white, fetid excrements, and very hot in coming away; flame-coloured urine, very fetid and froathy, and little in quantity; a dry skin; dryness of the mouth, with an ill scented scurff; blood burnt up with heat; sharp inflammations, which are quick and stubborn; and suppurations of a like nature; very fetid gangrenes; and cold, watry, acid or soapy things relieve in this case.

Signs of too great fluidity are plentiful perspiration, a great deal of sweat, urine and spittle; loose and large stools; leanness and contraction of the whole body; weakness, thirst, a disposition to motion, in which case thickening things are good.

The signs of too much thickness and viscosity are tumor, pain, uneasiness; circulation, secretion and excretion hindered, and become slower; a thick clamminess apparent in the humors in circulation, secretion and excretion; if with these signs cold also appears, it shews phlegm; but if great heat attend it, denotes a thick inflammatory humor. From whence we may understand the signs of water, salt, oil or earth, predominant. But if along with the above mentioned signs, there appear the signs of life, or a strong circulation, then quick and inevitable destruction is at hand; the opposite shew the contrary.

From all this well weighed, we may understand the signs of malignity in acute distempers: for since this foretels a sudden change of the distemper that ends in death, these signs may be deduced; *first*, from strong  
and



and quick causes applied to the body. *Secondly*, from the violent nature of the reigning epidemical distempers. *Thirdly*, from the known, natural and diseased temper of the sick person. *Fourthly*, from the stubborn resistance of all kind of medicines, which have a powerful quality to alter. *Fifthly*, from the ill symptoms, which shew that the vital functions are very much impaired, as, chiefly, an intolerable thirst, dryness, foulness, a white, yellow, brown, or black color of the tongue, with a crusty scurff in the mouth, nostrils, tongue, jaws and palat; a total loss of appetite; a perpetual and great and detestable loathing, continual vomiting and hick-ups; great pain and uneasiness about the stomach; a discharge of serum, choler, and a putrid humor from the stomach; liquid and fetid excrements, which do not relieve, but weaken; stringy fibres, bits of flesh and membranes being voided along with them; thin, red, froathy urine in a small quantity and often voided; a cold clammy sweat, falling in drops about the head and neck, not relieving, but fetid; a quick, weak, hard, unequal, intermitting pulse; a quick, troublesome, obstructed, deep and painful respiration; a depraved mind, with raving, madness and insensibility; no sleep, or disturbed and not refreshing, very troublesome or perpetual; spitting of blood, making bloody water, or a discharge of blood by stool; a few drops of black blood out of the nostrils; unusual tremblings of the tongue, lips and hands; strong convulsions, uneasiness, and a continual tossing of the head and limbs; lying upon the back, a careless hanging the feet out of bed, without perceiving them naked; tears falling of their own accord; the eyes sad, wandering, fixed or dry; voiding of excrements involuntarily; gathering of the nap of the bed-cloaths, and industrious feeling and groping about; purple spots; crises not relieving nor intire; and all unusual changes.

Acute distempers which may either be overcome by nature or art, are judged of by the absence of these  
signs



signs, and the contrary. Crudity, digestion, a crisis, and the event, by a change into a healthful state, some other distemper, or death, are the objects and signs of prognostication in diseases. That matter of a disease which is arrived to such a quantity, and is endowed with such a figure and cohesion of parts, as to produce or increase a distemper, is called crude, or the crudity of the disease; which may either be mixed with the whole mass of humors, or any one of them in particular. And the same is true in respect of the solid parts, since they may be affected with the faults of the humors.

This crudity is known, *first*, by the vigor of the distemper continuing or increasing; *secondly*, by the daily increase of the symptoms; *thirdly*, by the exercise of the functions, as yet, very much hurt; *fourthly*, but best of all, by the degeneration of the humors circulating, separated, and excreted, as also of the excrements from a sound state, in respect of their quantity or quality; whence it is indicated by sweat, tears, slime, saliva, thrown up by vomit, by cholera, the excrements, urine, a thin ichor, matter, blood, the menstrua, loches, milk, by abscesses, *aphthae*, breakings-out about the jaws, &c.

But if the matter of the distemper, which before was crude, is so changed, either by the actions of life, a proper disposition, or fit medicines, in respect of its bulk, figure, cohesion of parts, or fluidity, so that it differs less from a natural state, and is less offensive, and so abates the force of the distemper, it is then said to be, concocted or digested. And the state of the distemper, wherein this happens, is called coction or digestion,

This state of the distemper, and the matter of it, is known by the quietness of the disease, its decrease, and the strength either continuing or increasing. *Secondly*, by the decrease of the symptoms, attended with the natural strength. *Thirdly*, by the restitution of the functions



functions to a natural state. *Fourthly*, from the similitude of the humors circulating, separated, and of the excrements, with those in a natural state.

The causes which digest crudities, and make digestion, or coction, are the actions of life, the change of the morbid matter, and the assisting virtue of medicines. The matter of the distemper, being thus digested, is said to be resolved; and this resolution is a reduction to its natural state, without evacuation; supposing the humor to be of a good temper, and the medicines good.

In acute distempers, which consist in the humors, the disordered humor is so disposed, at a certain time, as to make a sudden change into a state of health, or death, which change is called a crisis, and the matter so disposed is termed critical. The cause of such a motion is the force of nature excited, by matter endowed with the several conditions of the distemper, to a discharge, so that it may either pass off or kill. If the matter be fit for evacuation, or to change its place, but yet not quite natural, it occasions a different change in the motion of the humors, from that which is in sound bodies, and this is called *perturbatio critica*, or a critical disturbance and disorder.

And these changes, which arise from the force of nature beginning to move, bring about, mix, or separate the critical matter, if they are sensible are called critical symptoms, or symptoms of a crisis, shewing it to be now present, or just at hand. The distinction of these is difficult, and the ignorance of them of ill consequence; for they are often confounded with the symptoms rising from the cause of the distemper, the distemper itself, or the crude matter of it, which often occasions wrong methods of cure.

The signs that distinguish the critical symptoms from those of the disease are, *First*, the former arise from the course of nature overpowering that of the distemper, but the latter from the force of the distemper prevailing over the vital faculties. *Secondly*, these are made after a preceding



preceding concoction apparent by the signs of digestion, and found good; the others appearing in crudities. *Thirdly*, these happen about the proper time of the crisis; the others all the time of the distemper, especially in the increase. *Fourthly*, these soon relieve, and those are presently prejudicial.

The primary of these critical symptoms and signs which precede a critical discharge are as follows. After concoction, at the critical time, there suddenly appears, as if from a new, manifest cause of the distemper, a stupor, sleepiness, and a heavy indisposition, watching, *delirium*, or raving, a great uneasiness, difficulty of breathing, and a troublesome night; a shivering, pain, redness, titillation, pricking, heaviness, and dulness of the parts, a dazzling darkness, brightness, and flashing light, tears in the eyes of their own accord, a loathing, great heat and thirst, an attraction of the hypochondria, and a trembling motion of the lower lip.

The present signs of a critical discharge which attend it, and continue, are, after those just now observed, vomiting, spitting, a discharge of slime from the salival vessels; a discharge by stool or urine; bleeding at the nostrils, womb, or hemorrhoids, sweat, abscesses, *aphthæ*, and a translocation of matter out of one part into another.

These critical discharges being known to be good, are not to be disturbed by art, if the symptoms abovementioned have preceded: if there be a good digestion, the distemper at its state, natural strength be good, the excrements natural, and suitable to the distemper, and the part affected, as also the life, diet, age, sex and temper of the patient, and the time and place agree, and the person finds relief as to the distemper and its symptoms; also if the color, heat, strength, pulse, respiration, and all the actions are presently restored, or begin to mend; and the critical discharge continues till the end of the distemper: If all these, or most of them, appear, there will be an entire discharge of the morbid matter from the sound, and this is called a perfect, discharge by *crisis*. But



But if such signs are wanting, and the contrary happen, then these are the symptoms of the distemper, and not of a *crisis*; and being ill symptoms, ought to be removed, as the distemper. But if all these are not present, only some of them, and those not perfect, then we know that it is a bad crisis, and that the matter changes its place, and may produce various symptoms which is called *Metastasis*, or a translation of the morbid matter out of one part into another.

From whence these and the like maxims are made, and received into the diagnostics and prognostics. A critical discharge after coction is always good. It is good if it happen on the critical day. It differs as to the time and matter, according to the age, temper, sex, climate, season of the year, disease, and epidemical disposition. Before coction it is bad. Coction itself is always good. The sooner coction is made the better, but not so of the *Crisis*.

Through what place the future excretion will be made we are yet to shew, with the signs thereof. This will appear from the tendency of the humor, and an alteration in those parts, to which it inclines, about which, or through which it is moved.

If it is to be made by hemorrhage at the nose, the hypochondria will be first extended, but without pain, and then the blood making its way more upwards, it causes a difficulty and shortness of breathing. After that follows a pain of the head and neck, a strong pulse, and the arteries in the temples are observed to beat more evidently; the face and eyes look redder, and the eyes shed involuntary tears, and shine, glisten, or have a mist rise before them; the imagination also is hurt, and the person raves, and fancies some red visions, and just when the hemorrhage appears, he begins to scratch his nose. And these signs are the more certain if the age of the person, nature, time of the year, and the present constitution of the air conspire.

If



If a *Crisis* is to be made by sweat, there commonly happens a suppression of urine, and after that a rigor or shivering, and when the sweat breaks out the pulse becomes soft, undulating and fluctuates; the external parts grow hot and red; the skin is soft, and the warm exhalations flow through it apace.

If by vomiting, it appears from a motion of the humors towards the stomach, which occasions a gnawing, with a pain of the head, a *Vertigo*, darkness of sight, a trembling of the lower lip, much thin spittle flowing out of the mouth, with a loathing; a shivering and coldness, tension of the *Hypochondria*, a hard and unequal pulse, and a difficulty of breathing.

If a *Crisis* is to happen by stool, there is no certain token, only the other signs are wanting; the person is troubled with wind, and a rumbling in the intestins, and a puffed up belly; also a pain of the loins, and a heaviness of the knees, and sometimes a suppression of urine precedes; or else it is made in small quantities.

If by urine the person does not toss very much, nor is greatly uneasy, but perceives a sort of weight in the *Hypochondria*, and a sense of fulness about the bladder, which sensibly increases, the excrements are retained, and the person, whilst he makes water, feels a burning heat.

If by the *Menstrua*, the time being present, there is a heat and heaviness in the loins, pain and tension of the *Hypochondria*, and the usual symptoms of that time.

If a *Crisis* is to be performed by the hemorrhoids, tho' this flux be otherwise familiar, the person will feel a heat towards the back-bone, and a pain and tension of the loins and *Abdomen*.

If the critical discharge is to be made through many places, the particular signs of each will appear.

And if nature designs to make a translation of the morbid matter to any part, which may occasion a future abscess, it is known by the disposition of the humors upwards and downwards; if the matter be thin it will rather



ther flow towards the upper parts; but if nature be strong, rather towards the lower part than the upper.

The knowledge of the event of a distemper is chiefly grounded on the knowledge and comparison of the causes, on which the present remaining life of the patient depends, and from whence the present distemper arises; for by these thoroughly considered we may foretel the event, whether it will terminate in life and health, another distemper, or death. And by this means we may know the times and changes which happen herein.

What it is that preserves life is known by the functions which are evident, as vital, animal and natural, which are delivered in these two axioms. The more like many functions are to those usual in health, so much the greater and better is the strength of nature, and so much the more hopes of recovery. And the more wholesome that function is in the sick person, on which a great many depend, as on their cause, so much the more likely is the patient to go through the distemper. The contrary conclusions are to be drawn from the contrary premises.

Now the function is known to be like that in health, if it hath the inseparable effects belonging to that function, and if the cause, matter and effect of the distemper be turned by those functions into health; it is also known by a good concoction of the morbid matter and the good discharge thereof. That is the best concoction, which soonest turns the morbid matter into a natural humor; and we know that the humors are become natural, and the solid parts restored, if the functions destroyed are returned again, and all the excretions appear natural.

The strength of the vital faculty is known from the age, sex, temper, life, country, and family of the person. And the force and magnitude of the cause of a distemper may be understood by knowing whether they are malignant, benign, or stubborn; also from the nature of the disease, by being acquainted with the epidemical disposition, the degrees of the symptoms, and the crudity, as well as the alteration of the sensible qualities, as to figure,  
bulk,



bulk, color and consistence, and the excrements much different from those in health.

The causes being well understood and compared, we may foretel, that if the cause of life be much stronger than that of the disease, the person will soon recover. If both these causes be equal, the distemper will be long or degenerate into another. But if the cause of life be inferior to the other, death of the whole, or of part must ensue.

The greatness of the danger in distempers appears from the great excess of the cause of the disease above the cause of life; and the continuance depends on its slow tendency to its state, as also upon the weakness of the person, and the stubbornness of the cause. That it will degenerate into another distemper may be known, when the force of the distemper and its symptoms remit without any coction, or any good and sufficient critical discharge; and that into a distemper with matter which is often worse, and of longer continuance than the former, according to the difference of the part affected, or the alterations of the morbid matter, or its time of remaining or settling in the part. The place where this morbid matter will seize and affect may be known by a tickling and itching, redness, pain and heat, a tumor, numbness, pulsation, agitation, and perpetual uneasiness of any part; also from the nature and disposition of the distemper; and if these accidents are either promoted by nature or art, it is a sign the distempered humor will be disposed of that way.

From whence it appears that the knowledge of coction and a *Crisis* are very necessary to make a true judgment in distempers; and that this is chiefly to be acquired by the knowledge of the vital functions, as the principal cause which is chiefly to be judged of by the pulse and respiration, whereof we shall next treat; and since urine is an excrement separated from the whole mass of blood, and all the parts thereof, and thrust out by the force of nature, this also ought to be carefully considered, to see how far it may shew the disposition of the blood and the degrees of concoction.



## C H A P. V.

*Of the Pulsation of the Arteries considered as a Diagnostic.*

SINCE the pulsation of the arteries shew the precise condition of the heart as the first mover, and also the disposition, quantity and motion of the whole mass of humors, from whence all the rest flow, with the different state of the artery it self, which is one of the principal parts of the whole Body, it is plain, that the doctrine of Pulses must be of great consequence in the art of diagnostics and prognostics.

A strong pulse shews, 1<sup>st</sup>, the great force of the muscular contraction of the Heart, and also the power of the contracting Cause, that is, 2<sup>dly</sup>, the strong and copious influx of the nervous juice from the *Cerebellum* into the fibres of the heart, 3<sup>dly</sup>, the quantity of the blood, and 4<sup>thly</sup>, that the circulation and secretion of the humors is well carried on; such a pulse therefore is an excellent sign, if it be the same in all parts of the body. It often deceives in apoplexies and some other distempers, where there is a free passage from the heart to the *Cerebellum*, and from thence to the heart again, while that in other parts is much obstructed, especially in the viscera. When weak, it betokens every thing different from the former; but sometimes deceives us in fat people.

A great pulse shews the quantity of the blood, the strength of the heart, the freedom and contractive power of the artery, a good circulation and secretion. A small pulse shews the contrary; a full pulse and an empty one may thence be understood as they are actually observed.



A hard pulse, so much taken notice of, shews a great many things, as that the membranes of the artery are dryer than natural; and therefore obstructions in the Vessels which compose the membranes of the arteries; it also shews the fullness of the arteries; but that their capillary extremities are obstructed with an inflammatory tenacity of humors; that the blood is very thick and compact; and that circulation, secretion and excretion are all perverted, besides those numerous accidents that flow from hence. A soft pulse signifies all the contrary, but is very deceitful in an acute peripneumony.

A rare pulse, shews that the contractions of the heart are slow in a given time, and consequently that the influx of the nervous juice from the *Cerebellum* through the nerves to the heart is also slow, that the circulation of the blood is free and equal, and that all the humors easily flow through the vessels; but if it be so from weakness, it is bad and dangerous. A frequent pulse shews the contrary; and sharp fretting humors, an agitation of the spirits, a fever and phrensy.

A pulse equal in strength and frequency, shews a constancy in health, and is good, and therefore an unequal one is bad.

An intermitting pulse shews the weakness of nature, and a sinking condition, and is pernicious.

A strong, great, equal pulse, and slow withal, is the best; strong and great, strong and slow, great and slow pulses are also good. A weak, small, hard, unequal, intermitting pulse which is frequent also, is worst of all; and so much the worse, the more of these meet together, and on the contrary. And hence we may easily understand, what a Mouse-like creeping pulse, or those that jarr frisk, or undulate mean, as also those that beat double or tremble.

The doctrine of pulses likewise teaches us, what heat signifies, which is the effect of the pulse. It denotes a straightened vessel, a thick humor, a forceable propulsion of the fluids; a great resistance about the extremities



ties of the vessels; and a slackness of heat, or its diminution signifies the contrary. The prognostics and the diagnostics both of heat and cold are understood.

But we are to take notice, that the nature of a particular artery, the age, sex, passions of the mind, the six non-naturals, the habit of the body, the peculiar disposition, the climate, and season of the year may very much alter these things; as also, which is of great moment, the order wherein different pulses may succeed one another. The pulse be most accurately to be observed, as it instructs us in the nature of the morbid matter and its motions; the manner of its preparation to make it fit for separation, and when it is just upon a crisis and beginning to be separated; for here it excellently shews us what is the convenient time for action, and when nature is to be assisted or left to herself; when discharges are to be promoted by art or committed to nature; and lastly, what manner of assistance is requir'd.



## CHAP. VI.

### *Of Respiration consider'd as a Sign.*

**A**N easy constant respiration, without pain, shews that all the organs serving to that action, are in good order and a healthful state; that the lungs easily dilate, and that the blood passes freely through them; and consequently that it is fit to circulate through all the vessels of the body; which is one of the best signs. But when perform'd with difficulty shews the contrary, and is consequently a bad sign.

And when respiration is very painful, it commonly signifies, that there is some internal inflammation: large or great respiration shews that the breast is easily dilated,



the diaphragm apt to move, and the abdomen easily expanded, as well as the lungs; that the blood passes easily through the vessels; and that the strength is vigorous; which is a good sign in diseases.

Small respiration signifies the contrary, and shews that the lungs give not free passage to the blood or some other matter; that they are stiff, and the pipes of them obstructed with some humor or matter, so that the air cannot pass out freely, which is a very bad sign.

Slow respiration shews the lungs equally free and subject to expand, the blood fit to circulate, and equally forced forwards; and is a very good sign, if there be no uneasiness or dulness of sense attending it.

Quick respiration shews, that the organs of that action are hurt, the lungs obstructed, stiff and dry, and the blood unapt to pass, and carries danger along with it. Equable breathing shews the lungs and other organs in good order, the blood well digested; but if unequal it proves the organs greatly disorder'd, and is a very ill sign.

Suffocative respiration, which occasions a sense of choaking, shews an inflammation, obstruction, plenitude, stiffness and dryness of the lungs, and the blood unfit to pass; and is presently mortal, except it proceed from slight convulsions in hysteric or hyphochondriac cases, or is usual, as in asthmatic persons.

Respiration in the upper part of the breast, shews the worst condition of the lungs stuffed up, and is consequently dangerous and mortal.

A high respiration which is perform'd with an elevation of the clavicles and an agitation of the *sternum*, a motion of the shoulder-blades, and drawing up of the nostrils, and also a great agitation of the lower ribs and abdomen, is mortal; for it signifies the most difficult passage of the blood through the lungs, and strength defective.

An easy, great, slow, equable refreshing respiration performed only by the gentle motion of the intercostal muscles,



muscles, diaphragm and muscles of the abdomen, is most healthful. And that which hath most of these conditions is best.

A difficult, painful, small, quick, sobbing, unequal, suffocative, sublime respiration, exercised with the utmost force of all the muscles concerned in respiration, is infallibly mortal. And the more of these faults attend, the worse.

Small respiration, with snorting, the lungs and throat being very hot, is quickly mortal, if other bad signs concur; for it shews that the blood can hardly pass through the lungs.

A great and quick respiration is often healthful, and is the sign of a good concoction and a crisis. A great and slow one shews the brain obstructed, and the diseases which rise from that cause, as *acoma*, lethargy, *delirium*, &c.

But in the mean time we are to consider, that respiration is very much disturbed and varied in several persons according to their native constitutions, and the different formation of the *Thorax*, lungs, diaphragm, and abdomen; and by the difference of age and sex, or being with child; also by passions of the mind, habits of the body and different climates, the seasons of the year and weather.

The different order of respiration in the course of its successions is of great use in diagnostics and prognostics: a change from bad to good, being the best, and the contrary the worst sign. That which increases in the time of a crisis is best. Since then respiration shews us the condition of the heart, lungs, and blood, the nervous juice and of the *pleura*, *thorax*, diaphragm and abdomen, it is plain that an accurate observation of it must be very serviceable to confirm the diagnostics and and prognostics of acute distempers.



## CHAP. VII.

*Of the Urine considered as a Sign.*

**H**E that would judge of the state of the body by the urine, must know and consider, that the urine of a sound person in it self and compar'd with other things is different according to the age, sex, disposition, season of the year, the use of the six non-naturals, and of medicines; and therefore in giving judgment of urine, the other symptoms of distempers are also to be accurately consider'd, or otherwise this art is very deceitful.

In considering and examining the urine, in respect of the diagnostic or prognostic signs in physic, we are to take notice of its quantity, color, smell, taste, fluidity, and contents.

The urine increased in quantity above what is usual, shews all or some of the following particulars; abundance of watry drink made use of, a relaxed state of the glands of the kidneys, that perspiration, sweat, and spitting, are diminished, that diuretics have been taken, or the imperfect mixture of the blood, so that the watry parts easily separate from the rest; affections of the nerves, or a hysteric or hypochondriac temper. Such urine also manifests the thickness of what remains, it's acrimony, thirst, uneasiness, obstructions and the effects hereof; are a diabetes, in which thirst; dryness, and sweat concur.

Urine made in a less quantity than usual, shews, 1<sup>st</sup>, a small quantity of liquids drank, or too much fermented spirits contained therein, 2<sup>dly</sup>, the vessels obstructed or contracted, or, 3<sup>dly</sup>, an increase of some excretion or other: and if it be quite stoped, it denotes an ischury and its various causes. Such urine foretells future repletions, heaviness, stupidity, and trembling convulsions, especially an apoplectic death, if it proceed from a second cause assign'd.

Thin;



Thin, limpid urine, like water, without color, taste, or smell, and made in great quantity, shews much water or watry liquors drank; the vessels of the kidneys very much contracted, and the humors briskly circulating, the strict cohesion of oyl, salt, and earth in the urine, their tenacity and difficulty of mixture with it; or violent passions of the mind, hysteric or hypochondriac fits. It also discovers the green sickness in virgins, or delivery to have preceded; that the viscera are unfit for coction, that the blood abounds with crudities and phlegm, and that the vessels and viscera are obstructed. In acute distempers it shews the want of concoction, and a crisis; also when the morbid matter is drove into the lower parts of the body. The same kind of urine foretels the same things as that made in too great a quantity. And in acute and inflammatory diseases it shews the worst condition of the viscera, raging, phrensy, convulsions, and death occasioned by a gangrene from the sharpness retained.

Red urine, without a sediment, in acute distempers, shews a violent attrition of the parts of the humors, and betwixt them and the vessels; it shews also an intimate and firm mixture of oyl, salt, earth and water, in the humors, and therefore a great degree of crudity in the morbid matter; and consequently the long continuance of the disease and a great deal of danger. Such urine shews gangrenous destructions of the small vessels, especially in the *Cerebrum* and *Cerebellum*, and death, also difficult concoction, a slow and very doubtful crisis; all which are the worse the redder it is, and the more free from sediment. Flame coloured urine without sediment, and thin, shews the same, but is much more dangerous.

Red urine with a plentiful, heavy sediment like brick-dust or bole, shews a great ferment and attrition preceding, relaxed vessels, sharp salt blood, dissolv'd and unfit for nourishment, strong intermitting fevers, and in northern climates denotes the scurvy. Such urine



shews the length of a distemper, the attrition, weakening and destruction of the vessels, dissolving sweats, urine and saliva plentifully discharged as well as the excrements; also consumptions and dropfies. If in such urine the sediment be branny or scaly it shews the same, but in a greater degree.

If the urine be of a saffron color, and stains what is put into it, or changes the glass of that color, and hath a sediment like the former, it denotes the jaundice, and its symptoms in the belly, skin, and *hypocondria*.

Urine of a green color with a thick sediment, denotes a melancholy temper, and that the dissolv'd matter begins to separate, which shews great uneasiness about the heart, and in the belly, iliac and cholic pains; which makes it evident, that this humor is dissolved and in motion, and flies through the blood and bowels, which occasions several acute distempers; from whence we may know what to think of black urine, that being of the same or a worse nature.

Blood, matter, caruncles, small filaments, hairs, little eel-like strings, concretions small sand of stones, and slime at the bottom, shew the faults of the kidneys, ulcers, bladder, testicles, seminal vessels, *prostrata*, of the glands of the *urethra* and of the *urethra* it self. But the nature of the evil denoted by these symptoms, and the part affected, must be learnt from the concurring signs, which appear in the several diseases.

If the urine appears fat, it hath commonly small sands in it, adhering together by a viscid slime, and so forming a sort of oily skin or membrane; which shews a great deal of earth and gross salts in the blood, and produces the scurvy, stone, &c. but urine which is truly fat and oily, though this seldom if ever happens, wou'd denote the vessels worn out with great attrition, dissolved and mixed with the blood and separated along with the urine; also sharp humors, a phthisis, and atrophy.

Urine, which upon shaking retains froth a long while denotes that the oyl and salt are united into a soapy substance,



stance, which encreases the tenacity of the mixture, and denotes a difficult concoction and crisis, distempers of the lungs, and catarrhs in the head.

Fetid urine, denotes salt and oyl attenuated, dissolved, and almost putrefy'd; which makes a great difference in chronic distempers as well as acute, and causes a difficult cure.

Urine coloured and without salt, shews the strength decayed, and death approaching; if pale and thin, with a slimy tough sediment, and hath a salt putrid smell, it commonly denotes the stone in the bladder.

The urine in acute fevers affords some prognostics, for when it hath a white, light, smooth, equal sediment, which soon settles, broad at top and small below, and hath scarce any smell during the whole time of the disease, even to the crisis, is a very good sign. Much white, hot urine with a copious sediment and white, discharged at the critical time, is a good sign, heals and takes away abscesses. Urine, on the indicating critical day, with a white or reddish sediment, being copious and relieving, denotes a perfect crisis on that day. Thin, dark colored urine with a sediment, also that which is thin and watry, thin and golden coloured and not turbid, turbid and not settling, in acute fevers, shews concoction hindered, great crudity, a difficult crisis, the length of the distemper, and the utmost danger; but in acute inflammatory distempers, sudden death; in moderate acute diseases that they will be long and troublesome with a future abscess, or a various translation of the morbid matter.

From the urine, therefore we may learn the disposition, strength and symptoms of the blood; the state of the disease and concoction; the state of secretion and the crisis; distempers of the kidneys, ureters, bladder, testicles, *vasa deferentia*, *vesicula seminales*, *prostate*, *Cowper's* glands and the *urethra*, with some disorders of the bile. The rest, if guessed at by the urine alone, are very uncertain and ridiculous.

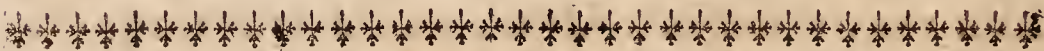




# HUGIEINE.



## PART IV.



### CHAP. I.

#### *Of the Necessaries to the Preservation of Health.*



HERE are three things necessary to the preservation of health; *First*, To have a regard to whatever may continue it when present; *Secondly*, To prevent distempers from the disposition of the Body, where they lurk, as in their seeds, and are easily stirred up; And, *Thirdly*, to dispose the body to long life.

Since



Since health, then, is an aptness in the body to exercise all its actions; and since this consists in a determinate disposition of all the parts, both solids and fluids, to motion, it follows that health it self, tho' once perfect, will from its own nature wear away the solid parts, consume the fluids, corrupt both, and so destroy it self.

Health, therefore, is preserved by restoring the same quantity, and quality, of all the parts in the body, such as they were, before their destruction, either in the solid or fluid parts. The matter which serves to this purpose is solid and fluid aliment, and in some measure the air, which are prepared and carried into the body by the vital, natural, and animal functions; and the same being thus prepared and apply'd to the places requisite, and which want repair; and by the same actions the body is freed from what is superfluous, crude and hurtful.

Wherefore, it is plain, that the whole art of preserving health is deliver'd in the chapter of nutrition, and the laws there laid down; yet it is difficult to express them so clearly, that they shall easily come under every man's observation, by reason of the proper disposition attending every single person; which therefore works different effects in men, that observe the same way of living; so that every one keeps his own health entire, though they severally make a different and quite opposite use of the six non-naturals; when on the contrary, if they should successively change their methods of living amongst themselves, those that suddenly alter'd they would be sick, who proceeding in their own way enjoy health.

And this custom, which is well enough call'd a second nature, goes a surprizing length in the effects of the air, meat, drink, motion, medicines, poison, or other things. Wherefore a sudden change from things usual to new, is always dangerous, though from ill habits to reputed good ones. But gradual changes,



changes, and often varying the way of living is the best method to preserve health.

Heavy air that is serene and dry, as such usually proves, is always and every where reckon'd most wholesome. The effects of the air are various, and either favourable or hurtful to nature; as we have shewn before, speaking of the causes of health and diseases.

The qualities of the air, which by their excess produce distempers may be altered by their opposites, as cold and moist may be changed into hot and dry, by the help of fire, dry woods and aromatics burnt; by the spontaneous exhalations of hot aromatics, obtain'd by the force of fire, hot wind let in, or forced out by art; but if the air errs in heat and driness, it is mended by dispersing cold dews, artificial wind, or by breathing watry vapors from cold plants soaked in water, as willow, poplar, rose-tree, elder, ash, mulberry, &c.

Therefore serene heavy air moderately hot and dry, blowing from clear inland places, or from rivers with a gentle breeze, free from sudden and great changes, open and rural, purged of salt and oily exhalations, is generally best to preserve health.

That food is reckoned most wholesome which is most simple, and free from gross feces and acrimony, and not consisting of too volatile parts, but most like to our bodies, most easily assimilated by coction, and, lastly, such as has acquired this disposition by means of the art of cookery.

Of this kind are all such things as are made of corn, and moderately dried and fresh, as wheat, barley, oats, &c. prepared by grinding, fermentation, baking, &c. so as to make bread of a grateful taste and smell; of pulse, green or full ripe, as beans, pease, lentils, &c. prepared by boiling, baking, stewing, &c. or of fresh and green pot-herbs, as the leaves of lettuce, savory, purslain, leeks, cabbage, mallows, beets, &c. moderately stewed in their own juice, or otherwise  
duly



duly prepared; of the more solid fruits, as almonds, nuts, turnips, parsnips, and such like; or apples, pears, prunes, cherries; or out of the juice and substance of sound animals, which are young and not too fat, as birds, beasts, fish, insects, or shell-fish, boiled, baked, fried, or stewed; also milk and eggs afford good and wholesome nourishment.

Hard, dry, gross, heavy, and clogging food is fit for those who have firm viscera and a good digestion, strong muscles, and use much exercise: But soft, slender, light diet is hurtful and unfit for such, or require that they should be continually feeding. But those whose viscera are weak, and have a difficulty of digestion, and live a quiet sedentary life, require a soft diet, like chyle ready digested, and prepared conveniently either by art or nature. In constitutions inclined to acidity, alkalious things are proper, and on the contrary.

And thus we are to judge both as to the quantity, quality, and preparation for our diet, first knowing the strength of the body, the nature of the humors, temper, age, sex, and the manner of living and employment of the person. Such a quantity of food is most proper for any one, by which he afterwards finds himself refreshed, without heaviness and dulness: Moderation is best for weak persons, and excess more agreeable to strong bodies.

Pickles made of acids, salt and aromatics, are prejudicial to sound bodies, hurt the small vessels, and creating a false appetite by their pungent quality, oppress the body more than they nourish it.

From hence we may understand what sort of drink is convenient, for if that be required only to quench thirst, and to dilute the thickness or acrimony of the solid food, then cold, clear, running, water, without scent or salt, and flowing upon a clean bottom, is the best drink for a sound man. But if such drink be necessary as warms, stimulates motion, and attenuates,  
then



then malt liquor is better, and that when it is purged of its dregs and settled, as also thin, grateful and pleasant; wines; the choice of which, their quantity and use, are to be judged of by the condition of the person.

Meat which is not too fat, with the drinking of water, makes bodies lusty and strong. Such motion as just raises a moderate appearance of sweat, or induces a small sensation of weariness, after digestion is begun, but with a mixture of lightness, is best; and this gives us also a rule for rest.

The best time for sleep is when the body is drowsy; and the best rule of waking is when the agility of the body dictates it. All medicines that cause a discharge, or are sharp and acrid, should be avoided; but cleansing the external skin by rubbing, washing, baths, fomentations, and swimming, are wholesome. Passions of the mind are not altogether to be suppressed, nor to be too much stirred up; the one occasions sluggishness, the other perverts circulation. Hope and desire are observed to be exceeding wholesome.



## CHAPTER II.

### *Concerning the Prevention of Distempers.*

**I**N order to prevent distempers, the cause is to be opposed as soon as we perceive the least signs of their approach.

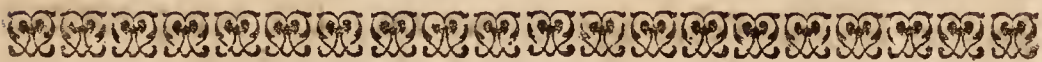
The best preventing medicines against distempers just approaching, are abstinence, rest, drinking warm water; pleasant and easy motion, continued till it begins to raise a moderate sweat, and a good, long sleep, the body being well covered; by which means gross humors are diluted, the vessels relaxed, and what was  
hurtful



hurtful is discharged; nor is there any thing which defends bodies more against the force of external causes, than to be slow in leaving off winter cloathing in the spring, and quick to put it on in autumn.

To this also a moderate diet much contributes, consisting of simple things according to the rules just laid down; in the summer the diet ought to be smooth and soft, loosening, moist, and gentle, of herbs, fruit, milk and broths; with a large quantity of watry or well diluted liquors, and a gentle motion of the body; all violent exercise being avoided.

In the winter grosser diet may be proper, which is hard and dry, seasoned with spice and salt, meat roasted, bread well baked, and wine sparingly drank; with the exercise a little more violent. In the spring and autumn the diet is to be moderate, in a medium betwixt that of summer and winter, considering which of the seasons is nearest.



### C H A P. III.

#### *Of the Diet proper to prolong Life.*

A sound body, by the actions inseparable from life, suffers such a gradual change, that the smallest vessels become stiff, and the minutest grow together into fibres unfit for humors to pass through; the greater vessels become hard and narrower, and all are contracted, and, being compressed, grow together, which occasions driness and unaptness to motion in old men. By this means the actions of the small vessels are destroy'd, and the humors stagnate and grow thick in them, and the fibres adhere together; thus the most subtle parts are wanting, digestion is weakened, nourishment



rishment is deficient, and the grosser humors only circulate through the large vessels slowly, and support life, without the animal actions, till at last these changes bring on inevitable death from old age, the successor of perfect health.

This happens sooner if the actions of life have been violent, but later if moderate. A just mediocrity here seems to promise long life, especially if the directions in the two foregoing chapters concur in their effects, so that they do not interrupt this end: The principal means for obtaining whereof are as follows.

All the actions of life ought to conspire, so that the lost parts may be restored, what is taken in assimilated, and the increase of growth continued to its just period, the feces being expelled, gently, kindly and daily. Exercise ought to be moderate and constant, till the beginning of weariness; in childhood, gentle, increasing gradually with the strength of the body, and to be lessen'd as age comes on; life being various in every condition, especially in husbandmen.

Those exercises of the mind should be chosen which are most suitable to every genius, and these are to be so governed and moderated, as not to dull or exhaust the Spirits, or prey upon them by too much action. In childhood too hard study is to be restrained, and the increase to be gradual, and in older years to be more moderate, and often varied as to the subject.

Meat that is simple, hard, dry, firm, and unapt to putrefy, without sharpness, consisting of bread, roots, fruits, which are a little rough, of the parts of animals a little salted, and fish prepared in the same manner, are most wholesome: In childhood, milk, bread, and strong diet by degrees, as they grow in years; and as old age comes on, the diet is to be altered again to that of children.

The drinking of good, cold water ought to be sparing, sufficient only to quench thirst, dilute, and



be serviceable to the constitution, and is best judged of by the effects; beer and wine, that are ripe, pure, and soft, should be used moderately, too much being very pernicious. In childhood, milk, gradually diluted, and then water; and in old age, soft wines.

In the mean time, great abstinence, the most thin, drying, or emaciating diet, very seldom used, is of great advantage. As old age increases, the introduction of nourishment into the parts may be encouraged, by external applications, as vapors, fomentations, baths, glysters, and unguents.

The air ought to be pure, and such as we meet with upon mountains, in the fields, shady woods, or inland places, and moderately cool. The discharge of gross humors, in old age, is to be promoted by mild and safe things, which excite the fibres, and dissolve the feces, or grosser excrements, such as saffron, salt, aromatic gums, with honey, and the softer kinds of wine.

The almost radical change of the humors, resolvents, and the discharge of them, as they are approved methods of cure, by the help of *Argentum vivum*, or by attenuating, drying, and sudorific decoctions, excellently dispose the body to throw off the old, and acquire a fresh supply of vital matter: By which means, artificial prudence may prolong the term of life.

Vapors, fomentations, ointments, baths, and glysters, of sweet and gentle perfumes, milk, broth, oil, and live animals, are very good remedies against the driness of old age, and prolong life, though hurtful in youth.

From what hath been said, it appears also, that those things which make the body large, hard, firm, and durable, and restrain violent distempers, often dull and obstruct the edge of the most lively mind, by rendering the organs coarse: Nor are the helps which cause the most perfect health the means to procure long life.



The great promises made with assurance, as to the prolongation of life, are vain and foolish, being unsupported both by reason and experience: Of this tribe are *Helmont's Primum Ens*, *Paracelsus's Elixir Proprietatis*; the *Primum Ens* of animals, fossils, metals and vegetables; often purging with the leaves of black hellebore, the use of spirit of sulphur by the bell, spirits of the flowers of rosemary, the virtue of a spirit drawn out of a young person, or long-liv'd animals which often renew their parts, and the influence of the stars.

Nor is it likely that life should be prolonged, even by the best method in nature, so many years as the chymists pretend, by their art; but their own experience shews their inability herein.







# *THERAPEUTICE.*

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## PART V.

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### CHAP. I.

*Of the Therapeutic Part of Physic in  
general, with the Method of healing.*



HIS last part of the elements of  
physic instructs in those general pre-  
cepts, which shew how a physician,  
in the cure of distempers, is to per-  
form these four offices; *First*, To  
preserve life; *Secondly*, To take away  
the cause of distempers; *Thirdly*,  
The distemper it self; And, *Fourthly*, the effects of  
that distemper.



To answer these ends the body of the patient is to be altered by art; to which purpose instruments are required; by virtue of whose application, the changes necessary to the performance hereof may be excited and made. And these instruments are called helps, remedies, means or medicines. But these remedies are to be so apply'd to every single person, that they may produce this necessary alteration; therefore a physician ought first to know what is there to be chang'd or alter'd, and then what remedies he is to use for that purpose; and consequently he should understand what effects will follow, upon the application and use hereof, in the sick person; both which he can only learn from those appearances in the patient, discover'd by the senses, or by just reasoning, from whence he may gain a true knowledge of the action inquired after, and the remedies.

And whatever is discovered in the sick person, so as to instruct the mind of the physician, is called *Indicans*, or the thing that indicates; and the knowledge of this arising in the mind of the physician, is called the indication; but that which is by this knowledge indicated to be done, is called *Indicatum*.

The *Indicans*, or thing indicating, is, then, all that is known in the sick person, or concerning him, either present, past, or to come, so that it may give the physician a knowledge of what is to be done, which is various and very different; yet it may all be reduc'd to, 1. The life remaining in the sick person, its causes, nature, consequences and degrees; and, 2. To the present disease, its causes, and disposition, with the consequences and symptoms thereof.

For from hence a physician learns, what is to be done to preserve the present life, to restore it when lost, and to remove what might destroy or diminish it; also what medicines are to be chosen to perform this work; how they are to be adapted and apply'd, and at what times, and in what order.

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That part of the therapeutics, which gives rules to discover what is indicated, is called the method of healing; of which we shall next treat.



## CHAP. II.

### *The Method of Healing.*

**I**N every sick person there is life remaining, together with its causes and effects; and these are called natural things, or things according to nature, and commonly nature it self. And since life is always in action, there will always be some actions remaining in the sick person which before attended health, and therefore may be esteemed the remains of the former health, and the effects of present life, and may be termed strength; which depends on the motion of the humors through the vessels, such as it is. And tho' reduc'd to the least degree, it yet continues the circular motion of the humors, through the heart, lungs, and *Cerebellum*, wherein therefore consists the least degree of life, which may be variously increased.

From whence it evidently appears, that these things being understood and consider'd by the physician, require the preservation of the sick person, and his restitution to a state of health: Which knowledge is called the vital, or preservatory indication.

The cause of the distemper known, indicates the correcting or taking of it away, and that cause being thought to precede the effect, the indication is therefore called the preservatory; but the disease being perfectly known, indicates the taking it away, which is called the therapeutic, or curatory, indication.



The symptoms being known, if they shew much danger or uneasiness, so that the cure of them cannot be deferred till the distemper they depend upon is cured, indicate their relief and mitigation; and this is called the urgent, or palliative indication.

From whence it appears, that what is to be done cannot be indicated, unless we first know, what life consists in, and its cause, also its state, strength, and effects; as also the distemper being known, and its state, strength, and effects, as well as cause: So that, first, what is to be done must be indicated, and then by what remedies, dose, condition, time, order, &c.

But since all these are in one and the same sick person, so that every one indicates some particular to be done, it often happens, that one indicates something different from the other, and sometimes a contrary, or a quite opposite remedy. From whence arises that useful doctrine of the thing indicating, or that which indicates the contrary, allows, vindicates, or likewise opposes the same, all which may easily be understood from what hath been already deliver'd.

When such contrarieties happen, there are physical axioms to determine, which of these doubtful indications are to be pursued, as, whatever indicates in a sick person, requires, the conservation, or the taking of it away. Whatever is found in the sick according to nature, that requires its preservation. The body consists of those things whereby it is nourished. Like things are to be preserved with like. The life which remains is the cause that cures diseases by proper remedies, to which the peculiar temper of every one concurs, and without which our labour is lost. Therefore when a vital indication equally urges, and also some other at the same time, the chief indication is to be preferred; and where unequal indications urge at the same, the greatest is to be regarded. Things that relieve, and those that hurt, chiefly indicate. Contrarieties are to be taken away by contraries. Nature loves things



things customary, and bears things unusual with uneasiness. In the greatest maladies the most powerful remedies are to be used quickly and at once. In less degrees of danger, milder medicines are to be given, and repeated gradually.



### C H A P. III.

#### *Of the Vital or principal Indication.*

**T**HE condition of life is known from its strength, which appears by its effects in the sick person; that is the exercise of the functions remaining, dependent on the propulsion and motion of the humors into the vessels and viscera; in which case there is required a just quantity of apt humors, and a continual action thereof through the vessels.

The action of the vessels wholly depends on that contraction of the fibres, by which, being separated from one another, and distended into an arch, they contract in their length, dispose themselves into right lines, come towards the axis of their cavity, and drive forwards the humors contained in them; and so this is properly the strength of the vessels, variously determined according to their figure. And it is plain, that this requires an elastic and contractive power of the fibres, which resists their distraction, or extensive motion.

And it also requires the influx of the most thin humor into the vascular membranes of the greater vessels, forced into the least nervous canals, and others, alternately to the propulsion of the grosser humors, through the larger vessels.



## C H A P. IV.

*Of Cordials and Diet proper for sick Persons.*

**S**INCE the heart, then, is the principal cause of all those motions which give us a just estimate of vital strength, the remedies which satisfy the vital indication may properly be called cardiacs or cordials, though they do not properly and immediately respect the heart alone.

These are very various, but they may be reduced to the following classes; *As, First*, Those which restore the just quantity of sound humors, or such as are like them in a human body; *Secondly*, Such as infuse into the fibres corroborating strength, and promote their elasticity; *Thirdly*, Such as increase the quantity of the nervous juice and its motion, that the small vessels being filled, the greater may be strengthened as well as the less; *Fourthly*, Such as stimulate the moving fibres, and so rouse up the sluggish vessels and stagnating humors.

To the first of these classes may be referred those liquors which are endowed with the faculty of nourishing the body of the sick person, and are so prepared before-hand, that they want not the action of chewing, nor digestion in the stomach and guts, which are either defective, or work too slowly in sick people who are weak and exhausted; or consist of such matter, as is not easily subject to putrefaction, whilst the expulsive faculty of the viscera is weak, or whilst something distemper'd, and often putrefy'd, as the *Saliva*, choler, or any other fluid, is mixed with what is taken into the body; *Lastly*, They ought not to be of such a disposition, which being like the distemper'd



per'd humors in the body, may cherish and increase their malignity, and so favour the cause, and exasperate the symptoms.

Such a cordial is indicated by the defect of strength, and the emptiness of the vessels; but the particular matter required in this cordial is known, if the proper disposition of the vitious humors be understood, which being predominant produces ill symptoms, for then it ought to be such as is opposite to that vicious humor; but this doctrine hath been taught in the semeiotics.

When, therefore, the humors are inclin'd to an alkaline nature, the matter of these cardiacs is best obtain'd from a due decoction of common grain, in clear water, after that has been well dried; thus it may be made into a thin ptisan, a thicker decoction, a smooth gelly, or a more solid gruel. The like preparations may be had from crumbled bread boil'd in water, into panadas of different consistences. Oatmeal and barley, and all kinds of grain and pulse, may serve for the same purpose. Emulsions also, and decoctions of almonds, pistachios, poppy-seed, &c. might here be added.

Again, from fruits well ripened, grateful and tart, or a little acid and sweet, especially such as are fresh and juicy, and candied, or boiled into a gelly with water and a little bread. To this purpose also, tartish apples, quinces, oranges, citrons, pears, &c. may be made use of; and sweet acids, as cherries, mulberries, grapes, elderberries, strawberries, &c. likewise soft pulpous fruit corrected by long boiling in water, and made more grateful with some candied or pickled preserves, as cucumbers, melons, &c. also plants, as fucory, purslain, sorrel, and such like; and, lastly, the milk of animals that feed upon herbs, whey, or skimm'd milk, and such like, may be used for the same purpose.

The choice and preparation of which, and the quantity and manner of using them, are indicated, by  
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the age, sex, disposition, and customary food; also by the cause, the disease it self, and its state, by its continuance in respect of the time past or to come, and its symptoms; likewise by the season of the year, the weather, &c. which happen with relation to the sick person.

If an acid disposition seems to be predominant, then these cardiacs are to be taken out of those animals mentioned in the first chapter of health, the firmer parts of which should be boiled with water into thin broth, or gellies, to different degrees of tenacity and thickness; eggs also may be made use of, and such sort of diet as is compounded of both these ingredients. But that is best here which is fed by other animals; and in the use of them all that is to be observ'd which we just now mention'd. But if a muriatic acrimony be predominant, those things mention'd as good in an alkaline temper may be used, tho' without being seasoned with salt. And if an oily disposition reign, the same things are to be used, tho' without oil or fat, and more diluted. It easily appears what method is to be used when the temper is too fluid or thick, in these cases the same things may be prepared after a respectively different and proper manner.

The second class of cardiacs are such as apply their parts to the flaccid and empty fibres of the vessels, which sticking thereto, render them stiffer; of which kind are all such as have a moderate astringent quality, as rough apples, pears, quinces, and fruits of the like nature that are a little sour or bitter, as medlars, myrobalans, acorns, berberies, myrtles, roses, &c. and such herbs as cinquefoil, tormentil, bistort, plantain, purslain, &c. pomegranate flowers, rose leaves, pomegranate bark, *Peruvian* and tamarisk bark; roots of capers, myrobalans, mastich, dragons blood, gum lac, bole, chalk, allom, steel, &c. These by their austere quality bind together the fibres which were slack and hung loose from one another, especially those that are  
very



very rough and acerb, as austere vegetables and fossils, unripe fruit, calcined vitriols, and bones: which are of most use when ground small. These are indicated when there is a great weakness in the whole body, with paleness, coldness, numbness, and superfluous ferocities, and the body is very flaccid, and the vessels empty.

But in applying these things there is a great deal of caution to be used, since austere substances work and shew themselves too much in the *Prima Via*, and act with difficulty amongst the internal parts.

The third class seems to consist in the most subtle parts of sound animals, that are young and strong, which may strengthen a weak body; and this seems to be done, by inspiring exhalations that flow from them, when apply'd to the sick person like a fomentation; and may also be done, by sucking milk out of their dugs; or by flesh well stewed in a close vessel; likewise by kindly and well scented odors, as of saffron, jessamine, citrons, oranges, bawm, &c. or brisk fragrant wine that is clear, sweet, and spirituous. These sort of cordials are necessary when the spirits are deficient, and there appear evident signs of a languishing state, as to the muscular motion of every kind, the exercise of the senses much hinder'd, and especially when the fluids clearly appear to be too thick in the other vessels.

The last class of cardiacs is so various that it ought to be subdivided into a great many more to be well understood; and, first come the fresh juices of all those fruits in which there is a grateful, acid, penetrating taste, and a sweet, refreshing, fragrant smell, and also some nourishing quality; as that of sweet and sour oranges, ripe pomegranates, good, scented apples, melons, cherries, strawberries, mulberries, prunes, &c. which in a hot and dry temper, attended with weakness, are very refreshing. And to this intention answers the scent of sweet vegetables, which have  
a gentle



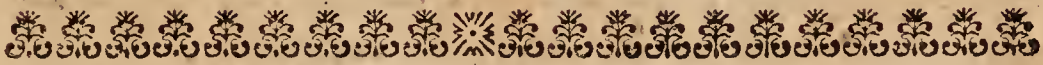
a gentle smell and grateful to many persons; as the rinds of oranges, citrons and lemons; flowers of borage, betony, bugloss, saffron, jessamine, lillies, maudlin, bawm, myrtle, sassaphras, rhodium, &c. or those things may be convenient which are hotter and sharper, as roman and common wormwood, dill, angelica, anise, mugwort, calamint, ground-pine, cummin, carowy, coriander, cinnamon, cardamoms, dittany, galangal, hyssop, juniper, lavender, laurel, mastich, penny-royal, rue, favin, sage, thyme, ginger, &c. also gums of firs, and others, as gum ammoniac, bdellium, elemi, galbanum, myrrh, opopanax, sagapenum, asafœtida, camphire, storax, liquid amber, &c. Some smells which are very particular have wonderful stimulating effects in many cases, as amber benjamin, castor, musk, dry and liquid storax, and civet, which are taken into the body and greatly act therein; there are many different orders and degrees of them, which being endow'd with a volatile, thin, sharp, stimulating quality, wonderfully affect the nerves, and may be reduced to acids, as wines, and vinegar, either simple or made aromatic, with the addition of Spices; or others more spirituous, as simple vegetable spirits prepared by fermentation, or impregnated with the fume of spices, or volatile alkaline spirits simple or mix'd; distilled oils of spices, or by expression, and a great many compounded of these as the artist thinks fit; to which external applications may be referred, and liniments, diet-drinks, &c. also simple and compound distilled waters, simple and compound balsams, lozenges and confections, compound, aromatic cordial spirits and oils, volatile, oily aromatic and spirituous salts of different kinds, and tinctures.

These are to be used with a great deal of caution, for when they are given in bodies, where humors stick in vessels not well disposed for the passage of liquids, they excite such motions and ferments as quickly



quickly prove mortal, by increasing the inflammation.

These sorts of cordials are indicated by the defect of the circulation of the humors, proceeding wholly from an inaptitude and sluggishness of the fibres, attended with soft humors, and vessels fit for a free circulation of the humors: What sort of them is to be chose, the consideration of the disposition of the distemper'd humors, and of the cordials themselves, will direct. And this may be sufficient to shew what diet is fit for a sick person, in order to remove a distemper.



## C H A P. V.

### *Concerning the preventive Cure of Diseases.*

**T**HE causes of a distemper being well known by their signs, indicate their removal; which if they reside in the solid parts, require a removal of the external cause that hurts or does the damage; or an union of the parts separated; a separation of the parts viciously joined together; the taking away of what is superfluous; and, lastly, an addition of what is wanting.

The things which indicate in these cases, being in the greater and sensible parts, require the art of chirurgery, which is wholly employ'd, to answer either by manual operation, or remedies the five intentions mention'd.

But if these signs indicating lodge in the inward parts, they are to be opposed by other remedies, though much like the last in operation. Amongst these, poisons are the principal, which we shall therefore first treat of.



## C H A P. VI.

*Of Antidotes against Poisons.*

**S**Trong poisons being taken inwardly, or apply'd outwardly, the causes appearing by their proper force, or by corruption began in the infected parts, indicate, *First*, The taking away of the poisonous cause; *Secondly*, The correction of it; *Thirdly*, Its expulsion out of the body; *Fourthly*, The mitigation of its symptoms; *Fifthly*, The arming of the body against the force of it taken in or apply'd.

The cause which spreads the poison and communicates it to the body, either mixing the contagion with the atmosphere, or being already applied to the body, insinuates it self therein, if it be known and sensible, may be taken away, *First*, by removing or destroying the poison'd or envenom'd thing, and chiefly by the means of strong and large fires; *Secondly*, by correcting the Air, that communicated the contagion, which is best done by the thick vapors of such things when burnt or made hot, as have an opposite disposition to the known poison. Thus in the plague, caustic, alkalious, putrid vapors are to be corrected by the fumes of vinegar, spirit of salt and gun-powder; poisonous acid exhalations by the scent of spirituous, oily alkalies. *Thirdly*, by changing, dissipating and renewing the air, by artificial winds, especially if it can be done according to *Hippocrates's* method of transmitting it by great fires kindled for that purpose. *Fourthly*, by avoiding it, and passing to high mountains in another place; Or, *Lastly*, by taking away or correcting that venemous matter already receiv'd into the body or apply'd to it.



The present, known poison is corrected by the application of such things as may destroy it's qualities that are hurtful to the body; which in a great many are scarce known, except by their deadly disposition, no otherwise discovered than by the death of the person infected; some are known by their surprizing and inexplicable effects, some by their effects which happen in other known distempers; and in others they are discoverable *à priori* by the cause, the nature of the poison being known. The first which are prejudicial to the whole substance require and indicate opposite remedies equally unknown with those poisons, as to the effects; and these are called antidotes, alexipharmics and theriacas, which are only learnt by experience and the doctrine of poisons.

The second sort which operate by an occult quality also requires remedies called specifics, that can scarce be found otherwise than by chance, but are to be met with in the history of poisons.

The third, before they kill, whilst they produce their ill effects, with which the fabric of the body is corrupted as in certain known distempers, require such remedies, as have been observed to do good in the healing of such distempers, as distinguish themselves by the like effects.

If the poisons be known which either are, or shall be applyed to the body, then those medicines ought to be made use of, that have the present and expeditious power of correcting that known malignity; and these have commonly an opposite violent malignity and would hurt the body, if the other poison were not first receiv'd into it.

Whence we see, that the disposition of the poison is to be known from the physical and medicinal history of poisons; by the mechanical and chymical arts, and by the effects appearing upon anatomical dissections; from which knowledge the indications here are to be taken. And from the indication thus taken, the matter of the  
correcting



correcting remedy must be known, together with its preparation, dose, application and management.

The chief and almost common antidotes against all poisons, which therefore are of most use where the poison given is known, tho' its singular nature be unknown, are chiefly these; pure water, a little more than blood warm, drank continually and for a long time; also injected and externally apply'd; a gentle lixivium of common water and *Venice* soap, used in a like quantity, manner and time; simple water made soapy with oxymel; sweet oyl, fresh and pressed out of lenient, fat and mealy substances or seeds, plentifully drank for a long time, injected, and applyed outwardly; and the like prepared of the oyl of fresh animals, boyled and diluted with much water; and in many sudden poysons, vinegar and opium. But a general preventing antidote is not yet known, nor is it reasonable to believe, it possible.

In giving particular antidotes there ought to be a great deal of caution us'd, for since they have a singular virtue of correcting this or that poison only, they have equally as great or a greater violent effect than that which they correct; and therefore these also concurring in the body mutually destroy one another, and do no great harm; but if given alone they are often found equally as hurtful as the poison which they are designed to correct.

But all these antidotes, whether universal or particular ought to be so prepared, used and directed, that they may be presently and always ready, without losing their strength, to penetrate to those places, where the poison is lodged; therefore the physician ought always to have in remembrance the class which contains all the diversity of applications, the principal of which are a suffumigation of the air, a dry or moist vapor for the lungs, draughts, glysters, epithems, baths, fomentations, injections for the womb, bladder, jaws, &c.



Poyson taken into the body is expelled first, by lessening the resistance in that place through which it may most safely be drove; where it will be the least hurtful; where it may have the quickest passage, and be least offensive to the principal viscera that serve in the functions of life; for then by the force of nature and medicines, it may be forced thither and expelled. This was formerly done by suction with pipes or horns, but now by large and strong cupping glasses, applied with flame and often renewed; by warm and very emollient fomentations, by leeches, scarifications, friction, heat and plaisters; secondly, by magnetic attraction, whereby a body, forcibly drawing out the venom, frees the sick person, as is reported of the flesh of venomous beasts, the stone *cerastis*, the stone of a serpent, and the like. Thirdly, By all medicines powerfully diluting and moving, as brisk vomits and purges, strong sweats, and perhaps diluting diuretics; whence *Diascordinum*, mithridate, venice-treacle, the *orvietan*, and opiate confections are serviceable; which yet are not to be trusted as universal curative or preventive antidotes. Fourthly, By speedily taking away the part affected with the poyson, which is best done by actual cautery.

The cruel symptoms, and sensible effects of poysons might easily be reduced into classes, and so be cured as if they were single distempers. The body may be arm'd against poyson to be applyed thereto; First, By using plentifully the general and particular antidotes which are only safe, when the nature of the poyson is first known, and it be previously understood what is to be applied. Secondly, By anointing that part of the body, where it is feared, with oily things. Thirdly, By keeping all the parts of the body in an equable transpiration. But no universal antidote hath been yet found out, as was before noted, though a great many have boasted of it.

And what hath been hitherto said of poysons may be said of the plague, contagion and other things, which



will be better understood from the following short account of the principal poysons, and their antidotes. *First*, some poysons may manifestly be referred to a particular acrid, burning caustic, occasioning a gangrene, and putrefaction, such as *Cobal*, yellow and red arsenic, white arsenic, sublimed realgar, *Armenian stone* and *lapis lazuli*; these applied internally, or externally, inflame, corrode, and occasion pain, heat, and dryness, *first*, in the parts primarily hurt, and presently in the whole body, bringing most acute and inflammatory diseases in the mouth, jaws, gullet, stomach and intestins; loathing, vomiting, dysentery, *Cholera morbus*, and iliac passion; a livid paleness, a vertigo, convulsions, and death; or if the person escapes death, a palsy and contraction. These symptoms indicate warm water a little acidulated, or sweetened with honey, to be drank plentifully, injected, and used in the way of baths. If it can be thrown out by vomiting and stool, it is so much the better, and those ought to be encouraged. Fat broth, milk, oyl, butter, and oily things are good. But those that are loosening, soft, fat and acidulated, should be taken inwardly, for a long time, as well as used in bathing.

The like sort of poysons among the vegetables are, wolfsbane, anacardium, anemone, *Apiumrisus*, *Apocynum*, aron, azedarach, *Cataputia*, *Chamaelea tricoccus*, *Chamaeleon niger*, *Clematitis*, *Colchicum*, *Corona imperialis*, *Cyclaminum*, *Dracontium*, *Elaterium*, *Esula*, *Euphorbium*, *Flos Africanus*, *Grana Nubiæ*, white hellebor, black and green, hermodactyls, hyacinths, *Laureola* and *Mezereum*, *Mel venenatum*, *Napellus*, *Nigella sylvestris*, *Oleander*, *Ranunculi*, *Ricinus*, scammony, oily seeds, made very rancid by long corruption, *Tithymali* and *Thapsia*. The effects and indication of these are much like the former, and require the same treatment.

There are other violent and sharp poysons, but yet in some measure viscus, which stick in the stomach,



mach, and affect the brain and nerves, after a particular manner, as the chrysomels, the greater and lesser hemlock like stone parfly, and the *Cicuta aquatica* of *Gesner*. To which, for another reason, we refer *Crocum*, *Datyra*, henbane, *Nux Vomica*, *Oenanthe apii folio*, with its poysonous juice, Opium, nightshade, *Melanocerasos*. These occasion vertigo's, dimness of sight, raving, madness, loathing, vomiting, dysenteries, horrid convulsions, apoplexies, and death. Hence they indicate the most immediate use of vomits, waters, oyle, or sweetened with honey, or acidulated, to be drunk in great quantities, and diligently to be repeated, by glysters, baths, and drinking. When the distemper is allayed, sweating often, by means of the theriacas, is convenient, and a soft and thin diet.

There are sharp poysons with a manifest acidity, as spirit of salt, nitre, *Aqua regis*, *Aqua fortis*, spirit of sulphur and vitriol; and the same acids united with metalline bodies, are made stronger, as a solution of gold, and its crystals; a solution of silver, and it's vitriol, *Lapis infernalis*; a solution of copper, and a salt made from it; a solution of quick-silver in spirit of nitre, salt, *Aqua fortis*, *Aqua regia*, or it's calcination with oyl of vitriol, and white, red, and green precipitate made from thence, corrosive, sublimate, *Mercurius dulcis*, and turbith; the impregnation of antimony with *Aqua regia*, and an escharotic calx made from thence. These occasion horrid tastes, acid fetid smells, inflammations, corrosions, gangrenous eschars, loathing, vomitings, dysenteries, *Cholera morbus*, most cruel gripes, heart-burnings, iliac passion, cholic, tumor of the glands, a putrid scent, salivation, syncope and death. These require to be diluted by water, and blunted by oyl, to be inverted and altered by lixivate, soapy, or slightly alkalious things, and the strongest absorbents of acids; and when the force is



prevented, the frequent use of oyl, fat broth, and emulsions.

There are other poysons which are mixed of acrid, alkaline parts, as the ashes of burnt vegetables; alkali's made from thence, and rendered hot and fiery, by an addition of lime-stone burnt, eggs, humors, flesh putrefied, and salts separated from thence, and the same made fiery by sublimation, from a fixed salt, lime, *Lapis calaminaris*, chalk, iron, &c. And these cause a quick, violent, and fiery inflammation, erosion, gangrene, burning pains every where, a great thirst, convulsions, acute fevers, a deadly smell, a total dissolution of the humors, and a putrefaction of those, as well as the viscera, and death. These require great dilution by water, and loosening things, and to be blunted by oily, fat and earthy oleaginous things, to be corrected by diluted acids, volatils, and such as are disposed to motion. The constant diet is to be acidulated, oily, and emollient.

Some things, by their singular acrimony, are often deadly, but so that this acrimony scarce shews itself any other way, but by its mortal effects in human bodies. As brass, *Æs ustum*, the calx of it made by corrosives, the flowers of it, and its scales, *Crocus* of antimony, the calx of it prepared by burning, also the glass of it; pure flowers of antimony made with fire alone, also with *sal armoniac*, and then wasted. These, taken, occasion loathing, vomiting, dysenteries, *Cholera*, too much purging, violent pain of the bowels, cramps, fainting fits, great uneasiness, and death. They also require diluting, emollients, and to be blunted by acids, and liquors sweetened with honey, immediately applied upwards, downwards and externally, and then opiates and oily things,

Besides these, they reckon six sharp poysons, that are merely mechanical, the diamond, mountain crystal, filings of iron, filings of brass, burnt alum, bruised glass,



glass, and the like. These prick the nerves, wound the vessels, occasion convulsions, hemorrhages, and ulcers, and indicate the immediate and plentiful use of butter and oyl.

There are poysons also, that by binding, thickening, obstructing and drying, kill soon, or slowly, as quick lime, and that slacked, *Gypsum*, lead rasped, or in scales, *ceruse*, *minium*, glass, litharge, the ashes of tin burnt, *synopsis*, *semen Psyllij*, *fungi*, *agaric*, the sponge of the dog-rose, bird-lime. These bind up, obstruct, and choak the vessels, often occasion miserable distempers, and after long languishing, death itself. They indicate the use of vomits, purging, diluting, spirituous acids, oyly, spirituous alkalies, and all soapy things, which are to be applied presently, long continued and repeated.

There are other sorts of poysons called heteroclites, wholly obnoxious to life, unintelligible, or not yet explained in their virtue and effects, but well known; which being taken, applied, or by a bite or stroke occasion death: as cantharides, spiders, the tarantula, asps, vipers, cerastes, prester, seps, a scorpion, a mad dog, a toad, buprestis, stellio, salamander, the *Lepus marinus*, *Pastinaca marina*, and the like. These produce various, wonderful, inexplicable effects, and then death. The indication here, if they be taken inwardly, is presently to make a discharge by vomit; to dilute very much by watry things, to mollify by laxatives and emollients, and such things as are oyly, to resist putrefaction by spirituous acids and salts. If they act externally by blow, biting, or application, then the poyson is to be drawn out through the place infected, by suction, scarification, burning, emollients, and fomentation, and plentiful sweating raised by penetrating antidotes, diluted and resisting putrefaction; the poyson also is to be weakened by acids, and saline or specific antidotes.



*Lastly*, there are some things which kill in a moment, by suffocating in the form of vapor, as the smoak of burning coals closely confined; subterraneous air long shut up; the steams of fermenting wines, and the fine dust of destructive fungus's, the fumes of sulphur, and a great many more such like. These presently so affect the lungs and the nerves, that they are scarce curable.

The remoter causes of distempers, being evident to the senses, are easily altered, or taken away, for they indicate an alteration in the six non-naturals. But if the same lye more hid, yet being known by their sensible effects, they indicate by these *Phænomena*, proper and fit remedies.

The course of these *Phænomena*, rightly observed, teaches us, by what medicines, in what time, order, manner and way we are to use them, to correct and expel the proximate or material cause of distempers in human bodies. Accurate observation of the same things also teaches us, what is wanting, and what substitutes are to be made. Also what motions ought to be excited and sustained, quieted, or diminished to obtain that end. Therefore an exact and regular knowledge of the effects tells us how to correct or take away the cause.

From whence we also know that there are two ways to lead us into the knowledge of causes, methodical and specific. The methodic way to know the cause, and destroy it, uses these helps and means; *first*, it accurately tries, finds, and regulates the *Phænomena*, or signs, and observes the course of nature; *secondly*, if the strength be wanting to perform those things which are necessary to drive out the cause of the distemper, it so supplies that faculty with cordials, or by removing those impediments, to which purpose such things as discharge the distempered humor tend; *thirdly*, but where the actions of life are perceived to rise too high, and



and so rather strike in than root out the cause of the disease, then it moderates matters so as to bring them to such a degree of force as is requisite ; which is done by watry dilutions, sweet softening things, and soft thickening ones, and such as discharge the natural cause of strength, by opiates and anodynes ; *fourthly*, by doing or changing nothing at all, but what appears necessary to be done from certain indications,

But the specific method takes away the cause of a distemper, by simply applying such a thing, as is known from custom to do good, without minding the four cautions just now mentioned ; this, therefore, only demands the name of the distemper, and the medicine, as in the cure of an intermitting fever by the bark, of pain by *Opium*, and of every particular sort of poyson by it's proper antidore, which either corrects the distempered humor, attracts or expels it.







## C H A P. VII.

*Of the curative Indication in Distempers of the Solids.*

**I**F the distemper lies in a similar solid part, the knowledge of it easily shews its indications; for if it be a solution of unity it requires for its cure; *First*, The taking away of whatever extraneous or dead thing is interposed betwixt the separated parts. *Secondly*, The bringing of them together into their natural place. *Thirdly*, That they continue so united without disturbance. *Fourthly*, That they be preserved in their natural humidity, heat, and softness. *Fifthly*, A natural agglutination by the help of what is lay'd down there, or apply'd by means of moderate, wholesome, and liquid nourishment.

The three first are performed by the hand of the surgeon, but the fourth by balsams, unguents, soft and smooth oyls, which resist putrefaction; as balsam of *Tolu*, *Pern*, *Palma*, *Capivi*, *Mecha*, native turpentine, butter, marrow, unguents, as *Arcens's* liniment and basilicon; expressed oyl of olives, oyl of line-seeds, digested with the flowers of balsamic herbs, as oyl of *St. John's wort*, marshmallows, agrimony, and lillies, and a great many compositions made of these. The fifth intention is answered by prescribing a regular diet.

If the solid parts appear to be too rigid and stiff, this indicates the use of relaxing applications, as fomentations and baths, convenient drinks, injections and steams of

warm



warm water, or applications of emollient decoctions of vegetables, as marsh-mallows, mallows, fenugreek-feed, and lin-feed, quince-feed, wheat and barley, or oat meal, in the form of cataplasms ; or embrocations of soft oyl, and, lastly, by moderate and often repeated motion.

Too great a relaxation of the solid parts indicates the strengthening of them, by the cardiacs before mentioned, and by a greater motion applied to the body by rubbing, riding, and exercise, by dry heat and warmth, with a like diet and air.

From whence it appears, what is to be done when elasticity is too much increased or diminished, and in too much weakness of the extremities of the vessels, as when they are crisp and easily broken, too much contracted, or distracted and drawn asunder.

The distempers of the organical solid parts, consisting in bulk, situation, and cohesion, have the same indications as mentioned in the chapter of preventive cure. But the other distempers of the solid parts depend upon the fault of the fluids, of which next.







## C H A P. VIII.

*Of the curative Indications of Distempers of the Fluids.*

**T**HE distempered humors being understood, indicate their alteration, or evacuation, and discharge, and that in the whole or the part affected alone.

The fault of a humor fixed in any one single part always implies the grossness of the humor, or the ill condition of the solid part, and therefore indicates a change of the humor as well as the vessels, that they may both conspire to a free passage.

When a humor is too gross to pass through a part, it may be rendered fit to circulate; *First*, By diluting watry things, warm, either in drink, fomentations, steams, baths, or injection applied as near as possible to the obstructed part. *Secondly*, By saline resolvents applied after the same manner, as nitre, *Sal prunellæ*, *Nitrum sibiatum*, *Polychrestus*, *Sal gemmæ marinus*, or *armoniacus*; the flowers of sal-armoniac with a fixed alkalious salt, borax, the salts of burnt vegetables, fixed and volatile alkaline salts, *Tartarum solubile* and *regeneratum*. *Thirdly*, By soapy things from an expressed oyl and a fixed alkaly, or from distilled oyl and a fixed alkaly, or expressed oyl, and a volatile alkaly. To which purpose the bile from of animals may be made use of, and the juice of absterfive plants, as lettuce, endive, succory, soap-wort, &c. *Fourthly*, By those things which are  
contrary



contrary to the cause of the coagulation, as when it arises from acids, by the use of lenient alkalies ; when from a glutinous cause, by things of a soapy nature, with the addition of salt, when such proceed from too much rest ; in phlegmatic cases, nitrous and soapy herbs are also proper. *Fifthly*, By cordials of a saline, aromatic, oily, and spirituous nature, which stimulate and correct the humors inwardly.

If the passage be stopped up and obstructed, it may be relieved ; *First*, By opening it, with the use of a drink, fomentations, vapors, and baths of warm water, altered with emollient and saline ingredients, and a moderate heat, and frictions either dry or moist. *Secondly*, It is to be done by cherishing, and mollifying, or chasing the matter lodged in the part with such things as soften and tend to putrefaction and suppuration, and to reduce the matter into pus, which is done by mild and gentle meals, as of lentils, wheat, barley, rye, oats, lin-seed, beans, pease, fennugreek-seeds, &c. The emollient roots of mallows, marsh-mallows, white-lillies, roasted onions ; flowers of mallows, marsh-mallows, and melilot ; leaves of mallows, mercury, figs, &c. the whites of eggs, sharp aromatic gumms, as ammoniacum, galbanum, opopanax, sagapenum, and fresh butter, and also by cataplasms, unguents, and emplasters compounded of these. *Thirdly*, By opening the way for the matter thus prepared by section or caustics.

The faults of the humors vitiated in the whole mass being known, as we have shewn in the semeiotic part, indicate the contrary medicines. Too much thinness or fluidity requires thickening, as by gellies made of the parts of animals and vegetables ; and drink prepared of water thickened by meal, without fermentation the actions of the viscera being increased and promoted by a good diet, exercise, and air, and confirmed also by the use of proper cordials and corroborating medicines.



If the humors be too thick, they are to be attenuated, by thin and light diet, as broths well boiled with attenuating herbs, such are endive, succory, smallage, &c. with white bread, as also by the use of sharp pickles or seasoning, as mustard, horse-radish, scurvey-grass, onions, leeks, and aromatic spices, &c. By diluting likewise with drink, fomentations, baths, and injections, made of watry things and assisted with heat, or the motion and exercise of running, riding on horseback, or in a coach. Also by stimulating sudorifics, diuretics, purges, vomiting, blistering, or mercurial medicines, and aromatics. *Lastly*, By strong resolvent medicines, as fixed alkalies, volatile, and soapy salts, and medicines compounded of such.

But too much motion of the humors in circulation, and separation, and expulsion, or excretion, indicate the appeasing of that motion, which is to be done, by taking from that stimulating quality, which excites the fibres thereto, and also by correcting it with its contraries; which is done by finding out the nature of the humor, and blunting the force thereof, by diminishing the quantity of the mass of humors, and laying them quiet, by the use of opiates and anodynes. But when that motion is too little, it must be raised and excited by taking away the impediment, by the use of evacuating medicines and correctives which attenuate, as also by cordial, strengthening medicines.

The acrimony of the humors being also known, indicates the dulling of that sharpness, by diet, made of such things as are almost insipid; for example, meal, gellies, and soft oily things, as milk with bread, and things something acid; fresh broth, flesh and fish; wheat bread well fermented and baked; fresh almonds, coconuts, and pistachios; sweet fruit perfectly ripe, drinking of water, and quietness of mind and body; by diluting the humors, with watry lenients, a little oily and emollient, in the form a ptisan or emulsion, by draughts,  
baths,



baths, glysters, or injection ; and, *lastly*, by opiates and anodynes.

If the humor be acid and acrid, that sharpness may be corrected, by convenient diet, as eggs, flesh and fish which are a little oily. and with such seasoning as disposes them to an alkalious disposition, as watry and fat oily drink, beer, *Brunswick* mumm, malmsy, canary, and *Spanish* wine, metheglin, &c. rest also is very convenient whilst the humors are sharp, but afterwards moderate motion may be useful, being gradually increased ; chearfulness of mind is likewise requisite and acid absorbing medicines, as crabs eyes and claws, bones of fishes dried, shells of fish, pearl, coral, and chalk ; also fat earths, as the *Armenian*, *Lemnian*, and sealed, blood stone, dragon's blood, filings of iron, reduced fine by rusting and grinding, and the like. Those, moreover, may here be used which turn the acid into a soft compound salt fit for circulation, as volatile alkaline salts, and fixed and lixivate ones ; also such things as are of a soft oily nature, and blunt the edges of such humors and prove emollient ; and, *lastly*, soft watry diluters.

Alkalious acrid humors require a diet, consisting of the milk of animals fed with soft herbs, or whey and skimmed milk. Fruit is good also, and acid mealy substances. The drink ought to be thin acidulated and slightly fermented ; the body should be kept quiet, and of a moderate temper, and here such medicines are proper as may alter this humor into a soft compounded salt fit for circulation ; such are all acids, sharp acid whey skimmed milk, or milk turned sowre, also such vegetables are here of use as have an acid quality, as sorrel, tartish cherries, barberries, the juice of oranges, citrons, lemons, *Rhenish* wine, vinegar, spirit of vinegar, *Rhenish* tartar, the cream and crystals of it, tamarinds, &c. likewise spirit of sulphur, vitriol, salt, nitre, pure and dulcified *nitrum nitratum*, or marine salt acidulated, which dull  
the



the acrid alkaline parts by being admitted into their pores ; to which purpose serve the troches of vipers, all sorts of soft and fat earths, as the *Armenian*, *Lemnian*, &c. or soft oyls which involve the alkalious parts, as all those that are newly expressed, sulphur with its flowers, and soft watry diluters.

Muriatic, or sea salt joined with acrimony, indicates a diet altogether without salt, a watry drink slightly acidulated with spirit, and emollient and diluting medicines, or lixivious ones of quick lime, and those things in general that destroy and serve to take away acrimony.

Oily, aromatic, choleric, putrid, or rancid acrimony, dictates a diet of insipid, unsalted herbs, acid fruit, and meat gently acidulated ; drink of water acidulated with oxymel, or a decoction of fruits ; the body at rest, and moderately cool ; soapy medicines gently acidulated, honey, manna, cassia, and sugar ; the juice of ripe fruits newly expressed, or the juice of some herbs, oxymel and sope, and all things in general that are good against acrimony. Acid, austere humors require the same as acrimony, and an acrimonious acidity.

Whoever duly considers what we have here delivered, and hath read *Hippocrates* and *Galen*, or is acquainted with medicines, will soon find out such as are fit to promote coction, and a *crisis* in acute or chronic distempers, either to excite or promote, direct or finish them : these intensions, consisting chiefly in attenuating what is too thick, mollifying sharp humors, opening the way where there are obstructions, strengthening the relaxed parts, and those that are too stiff or rigid, or moderating their motion.

From hence we may know what to think of the chymical principles, or the *Panacea*, or universal medicine, for this cannot operate by its own virtue in a dead body, but requires the assistance of life and motion to put it in action, so as to exercise its qualities ; nor does it act upon any one part that is dead, that  
still



still adheres to the rest, whether it be pus, ichor, or mortified, its virtues extending no farther than the living parts. It cannot restore the vital liquids of itself, nor change the matter, or *ichor*, into a natural humor. Nor does it restore the solid parts extirpated or consumed, either of the vessels, bowels, or limbs.

A great variety of distempers may arise from the same simple and material efficient cause, if applied to different parts of the body. Nay, a great many severe diseases are owing only to the varied motion of the animal spirits, and barely to obstructions in the part of life remaining ; and, *lastly*, only from cramps, or convulsive contractions, wind, small stimuli and poysons ; and hence it is evident that a great many distempers may be cured with one medicine, but not all. The most universal medicines hitherto known are water, fire, mercury and opium.



## CHAP. IX. Sect. I.

### *Concerning the curative Indications of Medicines which evacuate Fluids.*

**T**H E matter of distempers, or that which art indicates to be discharged, is evacuated two ways, *first*, by the natural emunctories of the whole external skin, and of the nostrils, mouth, jaws, gullet, stomach, intestins, bladder, and *Urethra*; *secondly*, by artificial ones



ones in the blood vessels by phlebotomy, or arteriotomy, scarifications, or leeches; and in the lymphatics, by caustics and vesicatories; but in both, by issues, setons, ulcers, and fistula's. So that the first distinction of evacuations is taken from the difference of the emunctory, through which the morbid matter passes, and the second from the difference of the matter which is discharged thro' every part.

### Sect. II. Of diaphoretic Medicines.

And, *first*, sweat is discharged out of the body, and the matter of perspiration, through the skin, and medicines that cause the former evacuation, are called sudorifics; or hydrogogues, and those which promote perspiration, diaphoretics, or perspiratives, which differ only in degree of action; and these are all such things as violently move the humors through the whole body, and diminish the resistance in the exhaling vessels about the skin.

The first is done by the plentiful drinking of warm water, also by acids fermented, and turned soure, especially distilled, belonging to vegetables, or the parts of fossils very much attenuated, and subtilized by often repeated distillations, especially if these are mixed and drank with water; by volatile alkalies also, and fixed ones diluted with water; and, *fourthly*, by all compound salts of this kind, dissolved in water; also crystals of metals, salts joined with them, or the metalline parts themselves, very much attenuated, and not too sharp, as common diaphoretic *Stibium*, and that of *Helmont*, the *sulphur stibii fixatum Tachenianum*, *bezoardicum minerale*, diaphoretic mercury, *Crollius's aurum diaphoreticum*, cinnabar, and a great many more; which are found to perform nothing sensible, and are, therefore, called diaphoretics, or to operate by the saline acrimony sticking



sticking to them, and then they often force out sweat. Sweating is also procured by spices, endowed with a sharp, subtle acrimony, as common and *Roman* worm-wood, southern-wood, asparagus, gum ammoniac, burdoc, brook-lime, betony, carduus, caroway, centory, cinnamon, saffron, maiden-hair, dittany, galangal, gentian, mustard, hyssop, laurel, motherwort, baum, mint, rosemary, rue, favin, sage, sarsaparilla, sassaphras, scabious, scordium, tansey, thyme, nettles, zedoary, &c. with the treacles compounded of these, mithridate, diascordium, *Elect. de-ovo*, the *orviatan*, &c.

The matter is promoted by a careful cleansing of the whole skin, by steams, washing, baths, and rubbing; by loosening all the cutaneous and subcutaneous vessels, and this end is well answered by the steams of water applied to the whole skin, except the head; it is also performed by an increase of external heat about the body, when naked in bed, by the vapors of a bath, or spirits of wine kindled; these acting gently, occasion perspiration.

The body is prepared for an easier discharge hereof, if required, *first*, by an attenuation and dilution of the humors, and a relaxation and opening of the vessels.

Sweating, and diaphoresis are indicated in diseases, *first*, by the beginning of a critical sweat, curing or easing the distemper; *secondly*, by the subtilty of the morbid matter dispersed, or to be dispersed through all the vessels; as in the plague, venomous bites, and the *Lues Venerea*, when the humor is very subtle, and not yet fixed; *thirdly*, by the particular disposition of the sick person; *fourthly*, by the epidemic constitution known; *fifthly*, by the various obstructions throughout the body, which are to be resolved, especially in distempers of the skin, as the itch, scorbutic eruptions, the leprosy, and the venereal distemper when grown ulcerous.



SECT. III. *Of discharging phlegm by the nostrils.*

All the parts of *Schneider's* pituitary membrane discharge themselves into the nostrils; this membrane is very large, and distributed through a great many cavities, and separates a mucus, mistaken for that of the brain; here also the natural humor of the eyes, as well as tears, are discharged, the liquid matter in a *coryza*, and the grosser in a phlegmatic catarrh; so that a great quantity of humors may be here evacuated by the force of nature in distempers, as well as by medicines.

This discharge is indicated, *first*, by a cold *coryza*, a catarrh, the sneezing distemper, matter falling down through the nostrils, and by distempers wherein watry humors flow hither; *secondly*, by the temper of the person, finding benefit from such a discharge; *thirdly*, by the revulsion to be made from the lungs in the distemper called *Bronchus*, a *Peripneumonia*, or a *Phthisis*.

It is increased and stirred up by fomentations, steams, or a decoction snuffed up the nostrils; *first*, of warm water boil'd with emollients a long time; *secondly*, the same being made sharper by the addition of honey or sugar; *thirdly*, by a decoction of betony, lavender, marjoram, rosemary, or rhubarb sweetened with honey, or sharpened; *fourthly* by these herbs twisted together, and put up the nostrils; *fifthly*, by every thing that is sharp and stimulating, as sugar, salt, *sal armoniac*, powder of antimony, tobacco, hellebore, *Euphorbium*, &c.

If this discharge be too violent it is stopped, especially if attended with sneezing, and the defluxion be sharp, by fresh milk warm, or mallows boiled in it, and snuffed up; *secondly*, by snuffing up the steams of lighted benjamin, mastich olibanum, amber, frankincense, or the milder spices or sweet scented herbs, as marjoram and penny-royal.

But



But if this discharge is much promoted, thro' ill custom, it draws too many humors to the part.

#### Sect. IV. Of the discharge by the salival vessels.

A large discharge of saliva, and the artificial evacuation thereof is indicated ; *first*, by a crisis made this way ; *secondly*, by the particular nature of the disease lodged in the glands and fat membranes, especially in the cure of the venereal disease ; *thirdly*, by the nature of the epidemic distemper

The body is prepared for it by the large and continued use of attenuating decoctions that are lenient, diluting, and actually hot, as scabious, pellitory, burdock, china, sarsaparilla, sassaphras, sanders, are the principal ingredients here. It is raised, *first*, by washing the mouth ; *secondly*, by the gentle and continual chewing of something tough things, as mastich, wax, myrrh, especially if sharp things be mixed with them, as pellitory, ginger, pepper, &c. *thirdly*, by drawing in irritating sharp vapors, as that of tobacco, sage, rosemary, marjoram, &c. *fourthly*, especially by the action of medicines, which excite a slight but continued loathing, as *Stibium* not quite fixed, nor yet quite emetic, a little common vitriol being taken at the same time ; *fifthly*, by those things that quite dissolve all the parts of the blood, and turn it into lymph and cause sputation, as crude mercury, cinnabar, a solution of quick-silver in aquafortis, white and red precipitate, turbith ; mineral, sublimate mercury dissolved, &c. But principally quick-silver, if the head, neck and face be kept warm, promotes that action.

Too great a salivation is lessened, stopped, or moderated ; *first*, by a large and constant use of warm emollient fluids, as a decoction of mallows and liquorice in milk and water ; *secondly*, by allaying its force with sweet oily, anodyne emulsions, diacodium, or opium



prudently mixed; *thirdly*, by making a revulsion to other parts by any large evacuation, especially purging. But here a great deal of care is to be taken lest the violence of this sharp humor moved should fall upon other parts with greater danger.

Sect. V. *Of emetics, or a discharge by vomiting.*

Vomiting is indicated, *first*, by the foulness of the mouth in a morning, and its bitterish relish, by rising, loathing, a gnawing of the stomach, and the appetite gradually declining, without a fever, or other cause attending; *secondly*, by spontaneous and easy vomiting; *thirdly*, by the nature of the matter known, being moveable or immoveable; *fourthly*, from the fullness and obstruction of the place affected below the diaphragm, especially if that affection is primary and nothing contraindicates; *fifthly*, by the general or epidemic nature of the disease; *sixthly*, by the constitution of the year.

Emetics are forbid by the contraries hereto. But the body is prepared to vomit more easily and safely; *first*, by making the matter moveable, by diluting it, attenuating and dissolving thereof; *secondly*, by relaxing and rendering the passage slippery with emollients, oily and soft things; *thirdly*, by first letting blood, if the body be full of humors, or too strong, and very much disturbed.

It is raised and excited; *first*, by irritating the spirits, thro' the presence of an idea that produces a great loathing, or some unusual agitation, as sailing, &c. *secondly*, by tickling the fibres of the jaws and pharynx with a feather dipped in oyl; *thirdly*, by drinking a great quantity of warm unsalted water, with oyl, honey, sugar, &c. *fourthly*, by every thing that is very sharp and viscus, as the flowers and seeds of dill, leaves of asarum, &c. *Crocus*, and glass of antimony, the flowers and



and regulus thereof, in substance or infusion, emetic wine, *Mercurius vitæ* and turbith mineral, which according to their different degrees of strength, have various effects; *fifthly*, by mercury made sharp with acids, which have various effects likewise, as the acid is more predominant and adheres to it more openly, sparingly, or latently.

The choice, dose, forms, and the time in the use of these are indicated by the age, sex, disposition, season of the year, and the nature of the matter of the disease which is to be discharged,

It is promoted by the plentiful drinking of water, warm and sweetened with honey, and repeated after every discharge. 'Tis also mitigated by the same sweet oyl drank, or opiates, aromatics, grateful acids, and strengthening things taken inwardly, or outwardly applied.

#### Sect. VI. Of discharge by purging.

Many things may be discharged into the stomach and intestins, and brought this way out of the body, as the saliva and slime of the mouth, jaws, gullet, stomach, both sorts of bile, the pancreatic juice, the diluted thin humor, or slime of the guts, the black cholerick substance of the blood, and of the viscera in hypochondriac persons, the serous humors of the blood, and any purulent matter from a critical abscess, whether symptomatic or original.

This discharge is indicated, *first*, by a flux of the belly, which is not consumptive; *secondly*, by the morbid matter, and its place; *thirdly*, by the part being full, and lying below the diaphragm; *fourthly*, by the particular, general, or epidemic nature of the distemper; *fifthly*, by revulsion; *sixthly*, by the signs of coction; *seventhly*, by the condition of the sick person.



It is forbid by the contrary; the matter to be discharged is to be prepared, if there be occasion, by the same things as in vomiting.

It is provoked by whatever dilutes and gently stimulates, and is received in a large quantity, the body being empty and hungry, and moderately cold; of this kind are mineral waters, either chalybeate and sulphureous, or saline, by drinking whey, or the juice of ripe and fresh fruit; *secondly*, by slippery lubricating things joined with a stimulating acrimony, sweet oyl newly expressed, fat broth, emollient decoctions, sugar, honey, cassia, manna, turpentine, pale roses, syrup of roses solutive, the juice of pale roses, gum ammoniacum, galbanum, myrrh, opopanax and sagapenum, taken in a moderate dose; *thirdly*, by gentle acrimonious things that are somewhat gross, which makes them stay and act in the first passages, as acid-sweet prunes, new figs, grapes, currants, rhubarb, tamarinds, myrobalans, tartar, aloes, mercurius dulcis, coarsely powder'd, and polypody; *fourthly*, by sharp things, as asarum, carthamom seeds, agaric, mechoacan, jalap, turpeth, hermodactyls, sena, scammony, diagrydium, and *flores Persica*; *fifthly*, by sharp caustics, as black hellebor, *veratrum*, iris, gamboge, elaterium, lapis lazuli, euphorbium mezereon, crystals of silver, white, red, and yellow precipitate; *sixthly*, by various compositions of these in several forms.

The choice, dose, form, preparation, and time, are indicated as in vomiting; but especially by the nature of the humor to be discharged, according to which they are called laxatives, purgers of choler, phlegm, water, and melancholy, and *Panchymagoga*, which bring away all sorts of humors.

This discharge is promoted by broth, fat, or buttered, fresh whey and the like. It is stopped by drinking of oyl, acids, astringents, opiates, spirituous things, and by revulsion to other parts.

A dis-



A discharge through the intestins by glysters is indicated; *first*, by the part affected; *secondly*, by the matter to be discharged; *thirdly*, by the strength of the person, and his disposition, and at the same time, a necessity of evacuation being urgent; *fourthly*, by the dryness, heat, and too much motion of the humors in acute diseases; *fifthly*, from a revulsion to be procured, and required in the fibres, and sharp humors.

Glysters are various; *first*, diluting ones made of whey, water, and new beer; *secondly*, emollient, and lenient, as of fat broth, oyl, emollient decoctions, milk, sugar, soap, and syrups; *thirdly*, milder stimulating ones; as salt or nitrous water, a decoction of the gentler purgers, urine, &c. *fourthly*, sharp ones, from decoctions of sharper medicines; *fifthly*, the most infallible usually are the smoke of tobacco injected.

From hence we may know the use of suppositories, whether moving, stimulating, or sharp; as honey boiled thick, hard sugar, and soap, mixed with acids of any degree. Where the same is to be observed, as in vomiting, or purging.

## Sect. VII. Of diuretics, or medicines that discharge by urine.

Evacuation by the urinary passages is indicated; *first*, by the signs of coction; *secondly*, by the critical flux of morbid matter through the kidneys; *thirdly*, by saline, soapy, subtle, terrene, scorbutic, or purulent morbid matter; *fourthly*, by the part affected; *fifthly*, by the epidemic constitution; *sixthly*, by the disposition of the sick encouraging this discharge, or being accustomed to it.

It is forbid by the contraries: but promoted; *first*, by the plentiful use of water, or watery fluids; *secondly*, by fixed, alkaline, and volatile salts, simple, or com-

B b 4 pound;



pound; *thirdly*, by neutral, fixed salts compounded, as marine salt, *Sal Gemma*, salt of nitre, borax, alum, tartar tartarised, or oyster-shells dissolved with an acid, in the body, or out of it, the juice of shell-fish, and oysters made with that, and salt ammoniac; *fourthly*, animal humors turning acid, acid whey, or four skimm'd milk; *fifthly*, by the gentle acids of vegetables, as oranges, citrons, lemons, and *Rhenish* wine; *sixthly*, by the acid spirits of vinegar, nitre, salt, sulphur, alum, and vitriol, simple, or compound, and salt of amber; *seventhly*, by smillage, and asarum boyled, asparagus, bitter almonds, wild carrot, eryngos, *Milium Solis*, parsley, pimpinel, saxifrage, &c. *eighthly*, all compositions of these.

Diuretics are assisted, by an empty stomach, good coction preceding, a gentle motion of the body, air a little cold, and warm things at the same time applied to the loins, hypogastria, the pubes, and peritoneum.

It is stopped, or prevented, by thick emulsions and gellies, astringents, and strengthening things; by opiates, &c. by determining the humors to other places, and by sweat continued for some time.

#### SECT. VIII. *Of discharges by the Menstrua.*

The discharge of menstruous or lochial blood is indicated, by the age, fulness of body, and any distemper depending on them, or their symptoms, as particularly in lying in.

It is promoted, by things determining towards the womb, by fomenting, and bathing the feet and legs; and by rubbing both them, the thighs, and hypogastria; and by cupping glasses applied to the thighs, and upper part of the legs, and often renewed; by bleeding in the feet, and plaisters of fetid gums applied to the navel, thighs and legs, *secondly*, by opening things conveyed in the form of vapors, baths, or fomentations



mentations into the womb, and vessels about it; and likewise inwardly taken, such as birth-wort, mother-wort, calamint, dittany, marjoram, mint, rosemary, rue, favin, tansey, fetid gums; aloes, myrrh, saffron, borax, steel, amber, volatile alkaline salts, and distilled aromatic oyls,

They are also to be promoted, by chirurgical remedies, diet and medicines, which are opposite to the particular impediment, in different tempers. If it be too great, it is stopped, by revulsion, astringents and opiates.

### Sect. IX. *Of Phlebotomy.*

Bleeding, at such distances as not to weaken, empties the veins and arteries, and makes the resistance in circulation the less, the vessels by this means being contracted, and yet full, are at liberty to exercise their elastic power of contraction. It also rarifies the blood, and makes room for its attenuation, and so opens obstructions, and promotes circulation, secretion and excretion. It also makes revulsion and cools.

By this means it relieves in abundance of distempers, and makes great alterations. It is indicated, by too great a quantity, and too great a resistance to the motion of the heart, and a suffocation by tumor, arising from too great a quantity, or rarefaction in the arteries. It also relieves from a threatened suffocation, by too great an extension of the vessels; when the blood is too thick and clogged; in great and inflammatory obstructions, where there is pain, tumor, redness, and heat, and a suppression of sweat, saliva, and urine; when circulation is either too brisk, or too slow, for the before-mentioned reasons. It abates heat in all the vessels, and the force of the blood upon any part, as, in hemorrhages, and fluxes. It is indicated also in known epidemical cases, and by the age, sex, manner of living,



ving, and temper, or an ill habit of body; and makes room for medicines, and the mixture of them with the humors, so that they may exert their power in great cures.

It is best performed with a large orifice, and in a large vein free from arteries, nerves, and tendons, quickening the motion of the blood while it runs, by strong respiration, and the motion of the muscles about the opened vein. The discharge is promoted also by the person's lying down; and the vessels are discharged by friction, bathing, and fomentations.

It is forbid in most chronic cases, where there is but little blood, and a great many obstructions; also in old age, and by the disposition, and the known epidemic, or endemic nature of the disease or a crisis otherwise determined; likewise by weakness, and a small quantity of blood, or after delivery.

From whence it appears, with what disadvantage this discharge may be made, or forbore.

The drawing blood out of the hemorrhoidal veins is indicated, by a melancholy temper, and distemper where the fancy is hurt, by the customary flux of those vessels now stopped, and the breaking out of it thro' new ways, which was more successful by the hemorrhoids.

It is promoted, by softening these vessels by emollient and hot fomentations made of water, oyl, honey, &c. and emollient glysters, and steams, by friction with rough things, and leeches; or by the use of aloes.

Scarifications act by stimulating and discharging, which lets us see the benefit of leeches. Setons, and issues, stimulate with gentle pain, affect the nerves, discharge serum, and empty the vessels, which shews when, and where they are indicated.

Medicines, that are stimulating, excite pain, heat, redness, by putting the nerves in motion, and acting upon determined parts, which produces a great many  
desired



desired effects; the want of which indicates their use.

Stimulation is made, *first*, by sticking plaisters, which applied hot, adhere closely, and being successively taken away, and fresh applied, make the parts hot, swell, and grow red. They are made of pitch, oyl, and bituminous substances, with castor, galbanum, pepper, pellitory, sal *Gemma*, and salt armoniac; *secondly*, by hot cataplasms applied, and left on till the part becomes red, hot, tumid, and itches; these are made of mustard, bryony, garlic, onions, watercresses, euphorbium, &c. *thirdly*, by vesicatories, or blistering plaisters; *fourthly*, by potential cauteries, applied like a poultice, or with lint; these are made of fixed alkalious salts, *Lapis Infernalis*, mercury sublimate, or alkaline volatile spirits and salts. They produce inflammation, and an eschar; *fifthly*, actual cautery, or a red hot iron.



## CHAP. X.

### *Of a palliative Cure.*

THE primary distemper is always abated, by mitigating the symptoms thereof; therefore whatever removes the symptoms almost at the same time, relieves the distemper; now the chief of these are pain, thirst, too much watching, and fainting fits.

Thirst, occasioned by the dryness of the whole body, is abated by frequent plentiful drinking, of a thin, watry, and mealy liquor, made grateful by something acid; also by a thin decoction of barley, oat-meal,



meal, bread, whey, thin veal broth, or small beer without spices; and lastly, by baths, fomentations, and glysters.

Thirst, occasioned by the dryness of a particular part, as of the mouth, tongue, jaws, or gullet, is appeased; *first*, by the abovementioned means; *secondly*, by gargarisms, and often washing the mouth; *thirdly*, by opening the glands and passages by epithems, and fomentations that are relaxing, moistening, and aperitive.

Thirst, occasioned from a sharp lixivate, or aromatic salt, is abated by all those things that dilute, with a mixture of acids and nitrous things; which shews what is to be done, when mauriatic salt is concerned, where watry diluting things are proper. But if thirst be occasioned by the unaptness of humors to pass thro' the vessels, then diluting and resolving things are indicated.

Pain, as a symptom, is eased; *first*, by diluting what is sharp, glysters with a warm decoction of the grains, drink, fomenting, and baths of warm water; *secondly*, by diluting, and resolving obstructions the same way, and resolving medicines; *thirdly*, by relaxing the nerves, with drink, fomentations, baths, and injections made of moistening, softening, and anodyne medicaments, gently dissolving, and correcting sharp humors, by the remedies beforementioned; *fourthly*, by blunting the sharp humor, and relieving obstructions from too much pressure of the humors; and by emollients, suppurative, and cleansing medicines. *fifthly*, by dulling the sense, by narcotics externally and internally; *first*, by gentle ones, as flowers, the seeds of poppies, and lettuce when full of milk; *secondly*, by stronger, as the ripe heads of garden poppies, when the seeds are out, and gathered before they are dry; the milk that drops out of *European* poppies almost ripe and wounded; *thirdly*, by *Theban*, or *Oriental* opium; *fourthly*, by the strongest sort, as mandrakes, nightshade, henbane, &c. of which fomentations,



mentations, liniments, and emplaſters being made, may be applied outwardly; and waters, tinctures, fyrups, powders, pills, and confections made for inward uſe, as diaſcordium, venice treacle, mithridate, *Philonium Romanum*, &c.

Too much watching from any thing that affects the brain, is very hard to be removed, and ſcarce without taking away the diſtemper, as appears in a phrenſy, *Coma*, melancholy, madneſs, &c.

If it be occaſioned by too much dryneſs, it is altered by food, drink, fomentations, and injecting, bathing with emollient and relaxing things, as marſhmallows, violets, lettice, and ſuccory. If it proceed from ſharpneſs, that is to be corrected; but if it ariſe from too violent a motion of the humors upon the brain, the cure is performed by derivation, baths, fomentations, and bliſtering plaſters applied to the lower parts, compounded of emollients and ſharp things mixed together, as emollient herbs with ſalt, vinegar, and ſharp leven, ſtrong ſpices, onions and leeks; *thirdly*, by repellents, at the ſame time, applied to the upper parts, as vinegar, or vinegar of roſes, violets and oxycrate; Oyntment of populeon and roſes, oyl of violets, poppies and henbane.

Opiates ſhould ſcarce be uſed internally in this caſe, except it principally proceeds from too great motion of the ſpirits, diluting and evacuating medicines having firſt preceded.

Too great excretions or diſcharges are to be relieved as mentioned in the preceding chapter. Too great evacuation of blood from the arteries and veins, being hurt, is ſtopped by comprels and bandage, actual cautery, thickening the fluids, and by contracting the ſolid veſſels, where the ſpirit of wine, and etherial ſpirit of turpentine are excellent.

Fainting



Fainting fits occasioned by stagnating humors, or violent convulsive cramps are removed by diluting and relaxing. But if they proceed from sluggish spirits, stimulating cordials are to be made use of. If from too much evacuation, the vessels should be filled; if from hysteric fits, fetid antihysteric medicines must be employed.

*F I N I S.*





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